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A HIPPOPOTAMUS HUNT IN EAST AFRICA.

WE publish herewith an engraving (for which we are indebted to our worthy contemporary Ueber Land und Meer) illustrating the return of a hunting expedition in East Africa. All of a herd of hippopotami had been killed but one, which continued to devastate the rice and millet fields; so a party, consisting of two boat loads, started off early one morning in search of the offender. The oars were used very little, for it was necessary to move as quietly as possible, but the boats drifted quite rapidly, and in about an hour reached the place that had been the favorite haunt of the herd. Nothing was to be seen of their sole representative. Presently, however, those in the first boat heard a noise, and when they turned they found the canoe behind them had been upset and all that was to be seen of the crew was the woolly black heads. The hippopotamus had remained quietly under the water until the first boat had passed and then attacked the second, but the natives soon recovered from their fright and swam to the shore with their boat, which was righted and baled out. Those in the other boat decided to land, for their boat was of slight build and ill prepared to withstand an attack by their enemy, whose head was uncomfortably near them. They concealed themselves among the bushes, and after watching patiently for some time with their guns turned toward the spot where the creature had been seen, the great snout reappeared, then the eyes were seen looking all about, and finally the whole head was above the water, making an excellent mark for the men to aim at. Five shots were fired almost simultaneously, the head disappeared, but remained under water only about half a minute, and then the gigantic body was seen to turn over several times, causing a noise and commotion like that made by a water wheel, then everything was quiet and only a few air bubbles indicated the spot where the colossus lay. It was two hours before the body rose to the surface again and could be secured and towed back to Mitini, where the party received a very warm welcome, the joyful "Jambo, Jambo!" of the negro women sounding loudly as the boats grated on the sandy beach.

A HIPPOPOTAMUS HUNT IN EAST AFRICA.—ORIGINAL DRAWING BY HERMANN HIRSCH.

SERPENTS' FANGS.

By HAROLD S. FERGUSON, F.L.S., in Science-Gossip.

THE general practice of dividing snakes into two divisions of poisonous and non-poisonous has been declared in the light of modern knowledge to be unscientific. It is well known that all poisonous snakes have poison fangs which are grooved, and that down this groove is poured the poison into the wound made by the fangs; but it has been found that certain so-called harmless snakes are also possessed of grooved fangs. These fangs, unlike those of the very poisonous snakes, are situated further back in the jaw; hence the family of the Colubridæ, to which they, equally with the poisonous sea snakes, and the cobras, and bungari of the Elapinæ belong, has been divided into three divisions: the Aglypha—that is, those not having grooved teeth—from two Greek words meaning "not" and "hollow;" the Opisthoglypha — those having grooved teeth situated in the back of the jaw; and the Proteroglypha, or those with grooved teeth in the front of the jaw. To the second division belong many of the tree snakes, and Mr. Boulenger writes: "Experiments recently made on Cælopeltis, a genus allied to Psammophis and Dryophis, have shown that these snakes are poisonous and that they paralyze their small prey before deglutition. It is probable that all snakes with grooved teeth will prove to be poisonous to a greater or less degree, as it is clear à priori that these grooved fangs are not without a function."

Another genus of tree snakes, Dipsas, lends itself to this view, for the species comprising it have a repulsive look, and with their flat heads and grooved teeth might easily be mistaken for the deadly poisonous snakes. I have, however, never seen them exhibit any signs of having injected poison into their prey. The common green tree snake of India is another possessing grooved teeth, but it is a very gentle snake, and the only one that the natives appear not to be in dread of, for they will handle it freely, though they take good care to tie up its head with a rag first. No other kind of snake will they on any account touch. The grooved teeth in this instance are quite at the back of the jaw. It is certain that the grooves must have been developed for some purpose, and it is therefore reasonable to conclude that they serve as poison ducts; but as far as one can judge from seeing these snakes feed in captivity, they simply seize their prey and swallow it once without letting it go. There is no appearance of the prey, usually a frog, being paralyzed by poison, and the whole act is performed so rapidly that there does not seem to be time for anything of the sort to occur; however, there are the teeth.

There are then several degrees of perfection as regards poison fangs represented in the teeth of snakes. First we have the grooved, fanglike teeth of the tree snakes, whose salivary gland gives a secretion the properties of which can hardly be said to be poisonous at all, or, at least, only in a very slight degree, the fanglike teeth being situated behind on a lengthened maxillary bone. Then there are the deadly Elapinæ, whose poison fangs are situated in front and the poison glands of which secrete an active poison; here the fangs are more deeply grooved or folded over to form a channel; they are placed on the front of the maxillary, which has a slight power of movement; and, lastly, we have the highly developed poison apparatus of the vipers, where the grooving has been carried on so far that the two sides of the groove have coalesced and formed a complete channel, giving the appearance of a perforated tooth. In these snakes the maxillaries have a considerable power of move-

ment, so that the fangs can be erected or depressed at the will of the snake.

To render these stages clear it is necessary to enter a little more into detail about the bones of the head of a snake. If the head of an ordinary harmless snake be examined, a bone will be found running from the point of the jaw as far back as the eye socket, of which it forms the base; this bone is called the maxillary. In it are fixed a considerable number of teeth. It is joined to another series of bones, also studded with teeth, forming an interior row; the bone joining it is called the transpalatine, or transverse bone, and the bones holding this interior row of teeth are called the palatine and the pterygoid respectively. The latter extends backward and meets a small bone called the quadrate, which unites it to the skull. This is the ordinary arrangement of the bones in the head of the common harmless snakes. Now compare the jaws of a cobra. Here the same three bones may be seen, the maxillary, the transverse and the pterygoid, but their relative proportions are considerably altered. The maxillary is much shortened and bears the grooved poison fang, with only two or three solid teeth behind it; the transverse bone is lengthened, and as the maxilla and quadrate bones are movable on the skull, there is a power of movement of the fang through an angle of about forty-five degrees, so that in these snakes the fang is partially erectile. The perfection of mechanism, however, is reached in the vipers, especially in the Russell's viper of India. Here the maxillary is shortened excessively and heightened so that it is higher than it is long. The transverse bone is proportionately enlarged and the maxillary is like the head of a hammer at the end of it. It bears the fang above, there being no solid teeth behind it. The effect of the snake opening its mouth is to guide forward the quadrate, which acts on the maxillary by means of the intermediate bar so that the lower side containing the fang is pushed forward and the latter can then be erected at the snake's pleasure by means of certain muscles. This movement gives the power of altering the position of the fang ninety degrees. When at rest, with the mouth closed, the fang is resting with its point turned backward along the jaw toward the angle of the mouth, but when the mouth is open the fang can be erected at right angles to its former position.

In the sea snakes, the maxillary is comparatively long, and there are two fangs with solid teeth behind. There is, in consequence, hardly any power of movement of the fangs at all.

A word as to the effect of the poison and the treatment. Generally speaking, we may say that the poison acts upon the nerves, and that the patient dies of nervous exhaustion. Hundreds of antidotes have been tried, most of which have proved of no use whatever. Indeed, so little effect have they in India, and so eager were people there to proclaim, without sufficient trial, that they had discovered an infallible remedy, that the late Dr. Shortt, of Madras, who experimented for years on snake poison, had, at last, to require a deposit of fifty rupees before he would undertake to try the so-called remedy. This had the effect of checking the supply of pretended antidotes. The only remedy at present found to be at all efficacious is strychnine. This has proved successful in Australia, where the snakes are nearly all poisonous, and nearly all belong to the subfamily of the Elapinæ, that to which the cobra belongs, but their poison varies in its intensity, and none of them appear to possess a poison as fatal to man as is the cobra's. There are few cases on record of men recovering, into whose veins the poison of this snake has been injected. All the cases of so-called recovery are probably due to the fact that the snake has bitten without injecting poison.

As to the remedial action to be taken, it must be remembered that rapidity of application is essential. In man the circulation of the blood is completed in from twenty to thirty seconds. It is, of course, slower in the capillaries, and proportionately more rapid in the larger veins and arteries. If, then, a man be bitten and the poison injected into one of the larger vessels, death will come rapidly. If, however, the poison has only reached the capillaries, the action will not be so rapid. Sir J. Fayrer recommends heroic treatment in cases of snake bite, such as deep cutting of the wound, burning, and so on. All this will probably be found useless. The best chance for the sufferer is to suck the wound, if he can possibly get at it, and, as far as possible, to stop the circulation at the part by tying a ligature as tightly as possible near it. Medical aid should then be sought as soon as possible. The natives of India pin their faith on the efficacy of "munthrums" or charms. One once informed me that his uncle had been cured in this way. On inquiry, it appeared that his uncle had been bitten, but that he had not seen the snake that bit him. He was first taken to a woman charmer, who said she could do nothing for him. He was then made to walk twenty miles to another snake doctor. Arrived there he became unconscious, but soon recovered. Now, this is a case which clearly shows that, if the man was bitten by a poisonous snake, no poison was injected. For had it been, he certainly could not have walked twenty miles. The symptoms were due simply to imagination, which, it is well known, will cause such to appear. The man would have recovered without treatment of any sort, but his faith in the snake doctor did away with all the harmful symptoms produced by his imagination. As to the snake doctors themselves, they have a firm belief in their own powers, and are not actuated by mercenary motives in professing to cure their patients, for, as a rule, they do not receive any pay for their treatment.

ITALY AND ABYSSINIA.

FOLLOWING upon the stirring events which led up to, and culminated in, the battle of Adowa, there has come a lull in the campaign. The Italians have spent the time in gathering themselves together, and taking the count of the survivors of the later terrible disaster, and the Emperor Menelek has been content to rest upon the laurels which had been gained in a brilliant victory over trained European troops.

It is certain that the overthrow of the Italian army will have a widespread effect upon the native African races at large. It has been pointed out by African travelers, who have an intimate knowledge of the country, that the tidings of Adowa would be quickly carried from end to end of the Dark Continent, and that its effect would be to shake the belief of the natives in the invincibility of the trained armies of the Circassian invader. It is quite possible that the increasing restlessness of the wild dervishes of the North and the recent outbreak of the Matabeles in the South have been stimulated by this crushing defeat.

Military experts are generally agreed that Gen. Baratieri showed great incapacity or recklessness in handling the Italian troops. The enemy appears to have fallen upon the van of his army suddenly and in overwhelming force, and this at a time when it was too far ahead of the main body of troops for the latter to render efficient support.

The van fell back in confusion and so crowded the main body that it was unable to take up any regular formation. It is urged that if a proper force of scouts had been thrown out ahead such a sudden attack by the Abyssinians in mass would have been impossible. The appointment of Gen. Baldissera was obviously the right thing to do. The policy which has lately governed the administration of Eritrea, and ended so disastrously, was bitterly opposed by him from the first. It was his aim to avoid any alliances with the native chiefs, and he managed to play them so adroitly one against the other as to thereby strengthen the position of the colony and extend its influence. He was opposed to the treaty with Menelek; and it was his distrust of the policy which has now resulted so disastrously which led to his return and the appointment of Gen. Baratieri. The career of Baldissera has been a checkered one. His childhood days were passed amid humble surroundings in Italy. Then we find him an officer in the Austrian army, where he gained considerable distinction. Later he returned to accept service in his native country, where he showed the same capability that had won him distinction abroad. One would judge from his portrait, which is reproduced from L'Illustrazione Italiana, that he is a man of great force of character, and he has shown that he possesses an uncommon share of civil as well as military administrative ability.

GEN. ANTONIO BALDISSERA, NEW CIVIL AND MILITARY GOVERNOR OF ERITREA.

Immediately after the defeat of the Italians at Adowa public interest was transferred from Africa to Europe; and it began to be asked what effect the reverse would have upon European politics. Russia lost no time in showing her sympathy with Abyssinia by decorating the Emperor Menelek with the highest military decoration she bestows, and this was followed by expressions of sympathy from Germany and England for the Italian government. Its effect has been, if anything, to accentuate the "status quo" of the European powers, and there is noticeable a tendency on the part of England to break away from her reserve, and identify herself more closely with the Triple Alliance. The sympathy of the latter power for Italy seems natural, when we remember that it was at the invitation of England that Massowa was occupied by Italian troops. The continued occupation of Massowa and the ascendency of Italian influence and power in this part of northeastern Africa is earnestly desired by the British government, as a check upon the turbulent tribes that inhabit the upper Nile country. When England undertook the task of rescuing Egypt from the chaos into which it had fallen, she had to perform the double task of reforming the internal affairs of the country and driving back the threatening hordes from the south. It is unquestionable that the Italian reverses have stirred up the military spirit in the warlike Mahdists, and the weakening of the grasp of Italy on the country to the east of them has emboldened the dervishes to commence an advance "en masse."

The intimate relation between Italian and British interests in northeastern Africa was clearly implied in a statement of Mr. Curzon, in the House of Commons, justifying the dispatch of an expedition up the Nile against the dervishes, in which he said:

"The Italians are not only engaged in battle with the Abyssinians, but Kassala itself is threatened by a force of dervishes estimated to be 300,000 strong. Obviously there are at present influences at work and forces unchained in Central Africa which, if flushed with victory, mean serious danger not only to Egypt and British occupation thereof, but to the peace of Europe and the cause of civilization. The government has been in constant communication with the government of Egypt, and the opinion of the military authorities both here and in Cairo is that an advance up the Nile is necessary. Consequently an advance of British troops has been ordered to Akasheh, one-third of the distance between Wady Halfa and Dongola, and it may ultimately be made to Dongola. The government was convinced that the steps which it had been decided upon would act as a diversion for the relief of Kassala, and also save Egypt from a menace which, if left alone, would grow to formidable dimensions."

This was on March 16, and on the following day the new Italian Premier, Marquis di Rudini, announced that on March 8 Gen. Baldissera had been instructed to treat for peace on the best terms obtainable. This was followed by the following significant statement:

"But the government is now convinced that in lieu of a treaty of peace, hurriedly made, it would be far preferable first to establish a state of things agreeing

with Italy's interests, and, in the meanwhile, hostilities must continue."

The chamber was then asked for a credit of 140,000,000 lire (about $28,000,000) for the expenses of the army in Africa; and it was voted unanimously amid great enthusiasm.

The cost of the Anglo-Egyptian expedition is to be met by the surplus of the Egyptian treasury, which amounted for 1895 to $5,500,000—a striking proof, by the way, of the prosperity of the country under British administration.

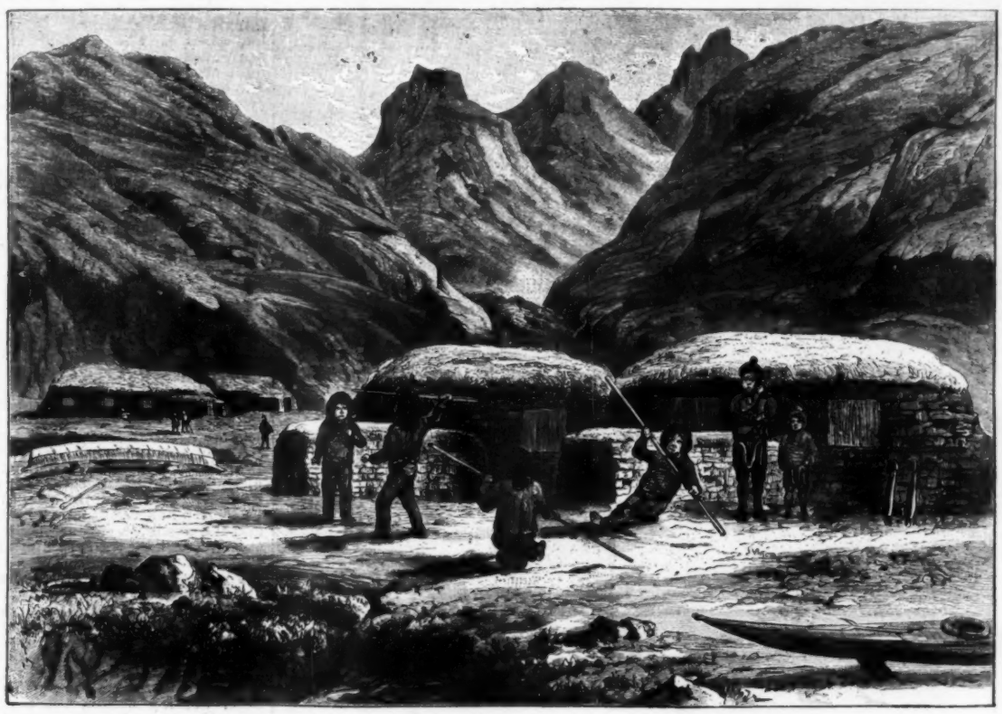
The latest news from Abyssinia is to the effect that on account of the rainy season having commenced, Menelek is withdrawing to the southern province of Shoa, taking with him the 2,000 captured Italians. The representative of Italy who was sent to treat with Menelek is also in his camp. Kassala and Adigrat are still held by the Italians.

PICTURES IN GREENLAND.

GREENLAND BOYS.

WHEN seeking food the Greenlanders are obliged to expose themselves to many dangers; they have to depend almost entirely upon what they can wrest from the sea, and therefore it is necessary that they should train themselves to be such skillful boatmen that they can defy the many hidden dangers of this element. To make good fishermen and able sealers a great deal of practice is required, and the Greenlander begins to prepare himself for this vocation while very young. Before the little child can stand steadily his mother puts a stone in his hands and teaches him to throw it at the dog that lies before him, and when larger he goes with other boys to a flat beach strewn with pebbles, where little stones are laid on the edge of a cliff and then knocked down from below, or he practices with a sling, trying to hit a piece of floating ice, or a bunch of sea grass, or a gull that is flying by. The boys practice on land with little javelins made for them by their fathers, throwing up a fish's head, an old leather glove, or other object, and then trying to hit it with their javelins; in short, wherever a Greenland boy is, he practices throwing.

But, as we have said, the sea and not the land is usually his scene of action when in search of a livelihood, and therefore it is essential that he should acquire the greatest skill in the manipulation of his little kajak, for the man must feel as much at home in his kajak as on land, and be perfectly able to keep his balance under all circumstances. When a boy he begins to practice on land, taking a round stone from the beach on which he seats himself, armed with a staff instead of a paddle, crosses his feet and then imitates the motions of a man paddling in a kajak, at the same time learning to keep his equilibrium. After his confirmation, often earlier—he is kept at school until he is fourteen—the boy receives a kajak of his own from his father, and then begins his real life training. His first experiments with the kajak are made close to land and under his father's guidance, and when he has gained sufficient experience to be trusted out a little farther he goes fishing or in search of gulls, which he kills with his javelin; and finally, he attains sufficient skill to go with the men and share their difficult tasks.



BOYS PRACTICING THROWING JAVELINS AND BALANCING THEMSELVES.—DRAWN FROM LIFE BY KARL SPINDLER.

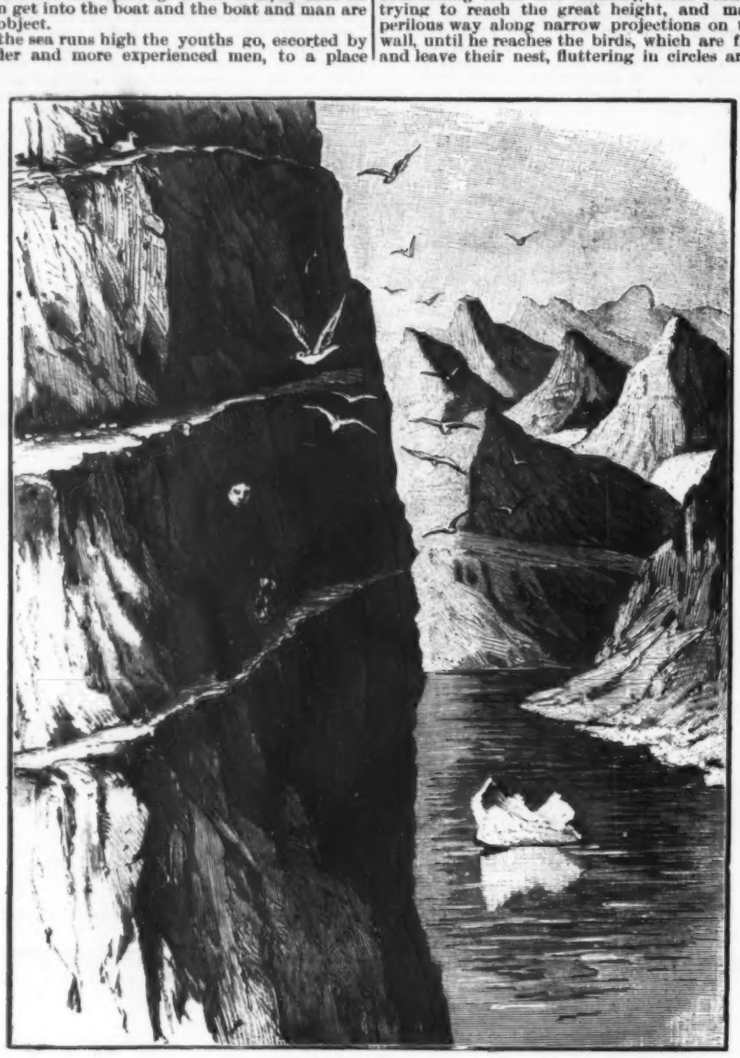
KAJAK PRACTICE.

Kajaking is a most delightful sport in good weather with a quiet sea, and at such times no special skill is required to manage these little boats, but the Greenlander cannot count on these favorable conditions, for he often has to go on the sea during storms, and even if he starts out in the morning in fine weather, if he has to go far out to sea in search of seals, he is very liable to be caught in a storm, and then he finds himself in no small peril, for the waves that break over him threaten to swamp the boat. In order to be able to cope with such dangers the kajakman practices in breakers, or where a heavy sea beats against a beach, the corner of an island, or at the entrance of an inlet. At such times he is dressed in clothes made of the soft, waterproof seal leather, which is fastened

KAJAKMEN PRACTICING IN BREAKERS.—DRAWN FROM NATURE BY KARL SPINDLER.

close around his face and wrists and stretched over the ring around the opening in the boat, so that no water can get into the boat and the boat and man are like one object.

When the sea runs high the youths go, escorted by some older and more experienced men, to a place



HUNTING FOR GULLS' EGGS.—Drawn from Nature by Karl Spindler.

where there are breakers, and there a spectacle well worth seeing is enacted. If the place chosen happens to be near the beach a number of spectators, adults and children, watch all the participants with the greatest interest. When a great wave that will form a breaker comes along some of the men move in the same direction as the wave, allowing it to carry them forward until it breaks. At this moment they turn, bringing their kajaks parallel with the breaker, so that it rushes over them. To save themselves from being upset by the great mass of rushing water, they have to lean toward it so far that there seems to be danger of their upsetting in that direction, and at the same time they have to work against it with their paddles. If a kajak is carried under by the breakers, it is not seen again for some time, and then the bow of the boat and finally the man sitting in it appear at a distance. When the man has recovered his breath somewhat, he goes back to wait for another breaker and then repeats the maneuver.

But is it not dangerous for a boatman to upset in this way when (as has often happened to the writer of these lines) there is no one near to help him? The Greenlander knows how to protect himself against such emergencies; he has studied the art of righting himself. If a man is completely upset so that he is under the boat, he can bring himself up again by a single powerful and dexterous stroke with the paddle, but generally he works himself up by a zigzag movement of the paddle. For the sake of safety this motion is practiced with the left hand as much as with the right, so that he can recover his equilibrium as easily on one side as on the other. Usually, in righting himself, a kajakman holds his paddle in front of him, but not a few hold their paddles behind their backs or necks, or even diagonally under their kajaks. Some learn to right themselves by means of the board that they use in throwing the harpoon, or of the shank of the harpoon, and a few understand how to right themselves by a single arched motion of the outstretched arms and the flat bare hands.

EGG HUNTING.

The courageous Greenlander accomplishes many astonishing feats on land as well as on the sea. During a reindeer hunt he is often obliged, when heavily laden, to make his way over dizzy precipices, or if he notices that a pair of falcons have made their nest on a steep wall of rock, he cannot rest until he has climbed the rock, if this is at all possible, reached the nest and taken possession of the eggs, which he then sells for a few groschen to a European collector of natural curiosities. The collecting of gulls' eggs has an especial attraction for the Greenlander, for these birds build their nests on rocks that are so steep as to seem inaccessible for men and foxes. The brave Greenlander shuns no danger in reaching the nests, clambering over rolling stone and climbing from rock to rock, trying to reach the great height, and making his perilous way along narrow projections on the rocky wall, until he reaches the birds, which are frightened and leave their nest, fluttering in circles around the robber. When he has put the eggs in his kerchief or his sleeve he hurries back by the same breakneck path. Woe to him if he should be seized by an attack of vertigo or his foot should slip! A fall into the terrible depths below would then be unavoidable and he would pay for his foolhardiness with his life; but the man is cautious, he knows nothing of dizziness and he is very sure footed. So he returns in good condition, with his booty, to his people and the kajak he left on the shore. Then the eggs are tested and the fre ones separated from the others; the former are s to a missionary or an agent, while the latter are cook and eaten with a relish by the family.—Illustrir Zeitung.

TRICKS PERFORMED BY THE ILLUSIONIS CHEV. E. THORN.

We publish herewith an engraving illustrating trick performed by the illusionist Chev. E. Thorn, full view of an audience. On the stage are two cag like boxes, each large enough to receive a person in upright position, and each formed of slats, so that t audience can see through them in all directions, a when the operator moves behind the cages he is pla ly visible. Because the cages can be seen through easily as they stand there with open doors, it see impossible that there can be any double walls or oth like device arranged in them. After the performer h demonstrated this he pulls down red silk curtains ov the side walls and the doors; the rear wall, howeve remains uncovered. Now a brilliantly dressed odali steps into the box at the left. The doors have scarce closed behind her when they open again, the curtai fly up, and it is seen that the woman has disappeare and in her place stands a white bearded caliph, wh she appears at the rear door of the parquette smili behind her veil. She passes down through the a dience to the stage again. In the meantime the cali has left the stage.

What follows is even more surprising. The curtai of both cages are pulled down, the caliph goes in the cage at the left and the odalisk into that at t right. The cage containing the odalisk is raised on hoisting rope so that it hangs in midair with t doors open. The doors are closed, a shot is fired; the same instant the doors of both cages spring op and the curtains are raised; the odalisk has disa peared from the cage, which stands again on the flo of the stage, but, at the same instant, she steps, smiling as ever, from the cage at the left, from whi the caliph has vanished. The two cages stand op and the audience can see right through them. T curtain falls and the spectators rub their eyes in b wilderment.

The illusion is created as follows: The cages are pr vided with three very simple arrangements. There a board or little platform on the rear wall of ea cage, on which a person can stand, a door opening i ward, and a screen that can be easily adjusted to cov the spaces between the slats, but is not noticeable b cause it is of the same color as the rear of the stag The performer takes great pains to deceive the aud ence, walking behind the cage as often as possibl when the screen is open, so that he can be seen. Th carpet on the stage, the back of the stage and th screen, are all of the same shade of green. When th curtain rises the caliph stands on the little platform the cage at the left, hidden by the cage and the scree Attention is then called to the cage at the right, th screen in which is open, so that the performer is abl to demonstrate to the audience that they can s through the cage. The pulling down of the curtain serves simply to conceal the entrance of the caliph int the box. When the odalisk is to vanish and the calip to appear, he slips in very quickly from the board o the outside, while the odalisk takes her place on th board behind the screen. The odalisk who appears the door is an exact double of the one on the stage. I the second trick the real odalisk is standing invisibl behind the screen on the board of the cage at the left while the caliph installs himself in the cage; the fak odalisk is raised in the air in the second cage, throug which the audience has been able to see up to th time; any disturbance of the center of gravity woul cause a suspicious swinging of the cage; so the shot fired and just at that time the odalisk moves ver quickly on the board behind the screen, and the cag is let down and stands firmly on the floor. At the sam instant the odalisk in the other cage changes place with the caliph. The swinging cage appears to b

TRICKS PERFORMED BY THE ILLUSIONIST CHEV. E. THORN.

mpty, and apparently the odalisk has passed invisibly through the air to the other cage. The success of the illusion depends upon the rapidity with which the trick is performed and the skill of the performer, making the spectators believe that everything is done in stages through which they can see.—Illustrirte Zeitung.

THE GEDDES PULSATOR ECONOMIZER.

WE have pleasure in illustrating and describing the Geddes pulsator economizer, in connection with the latest arrangement of this specialty for triple expansion engines. This steam drain trap is one of the most efficient that has as yet been introduced, and is simple in its action, as will be seen from our illustrations.

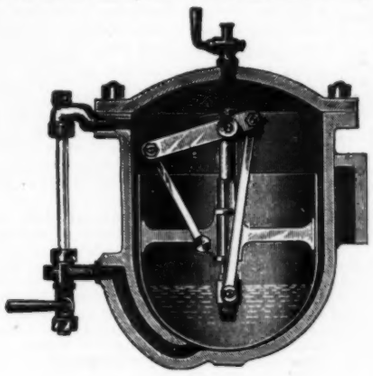


FIG. 1.

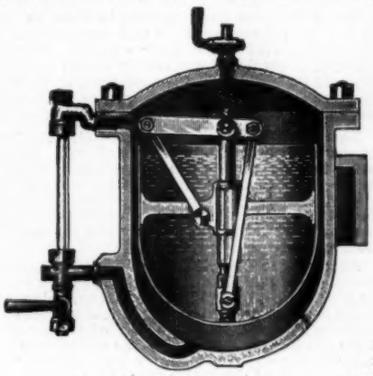


FIG. 2.

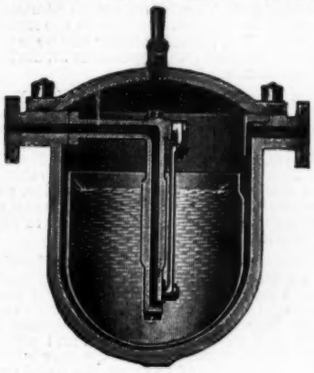


FIG. 3.

THE GEDDES PULSATOR ECONOMIZER.

Fig. 1 shows a section of the trap with the float empty, the valve being closed, Fig. 2 with the float full and just about to descend, the valve being still closed, Fig. 3 shows a transverse sectional view of the apparatus, the float being in the act of discharging its contents with the valve full open, and in Fig. 4 the arrangement is shown as applied to two cylinders of a triple-

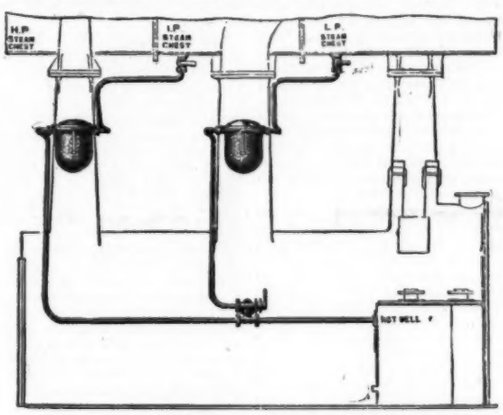


FIG. 4.—THE GEDDES PULSATOR ECONOMIZER.

expansion engine. The float is made in the form of an inverted dome, and is free to move on the center spindle, which is also the exhaust pipe for the condensed water. The bottom forms a stop to prevent the float from rising too high, and by a system of levers a small circular slide valve is moved up the center spindle when the float sinks. The water entering the trap and filling the space between the casing of the pulsator and the float first causes the float to rise, and after the water has risen above the level of the float, it overflows and fills the interior, causing it to sink, and in so doing opens the small valve at the bottom of the center spindle. The pressure of the steam on the water within the float at once blows the water away to the hot well or condenser, as the case may be, when applied to engines, and when sufficient has been blown out, the float again rises to repeat the operation. The action of the trap is steady, and the opening of the valve sufficiently large to permit the particles of dirt, etc., getting away easily, and at the same time the valve is sufficiently powerful to remove any obstruction on the face of the spindle, and thus do away in a great measure with leakage. The gage shown in Figs. 1 and 2 enables the engineer on watch to see what is going on inside the trap, while a few bolts in the cover of the casing can readily be disconnected to enable him to inspect the internal parts.

The pulsator certainly has simplicity as a recommendation, and its fewness of working parts must reduce the annoyance which is continually being felt and experienced by engineers, more especially those at sea, in having to take the trap apart for cleaning. In the pulsator it will be readily seen that the valve is bound to open to the fullest extent as soon as the float sinks, and the emptying of the float causes it to shut as closely as before. An air cock is fitted on the top of the vessel, and this also affords a means of supplying a little oil to the interior, which, floating on the top of the water, lubricates the various working parts. Any accumulation of dirt in the bottom of the vessel can be blown off by the bottom gage cock.

The pulsator economizer has been invented and patented by Mr. Chris. Geddes, consulting engineer, Liverpool, and is manufactured by the firm of Thos. Richardson & Sons, Limited, Hartlepool. We are indebted to the Engineers' Gazette for the article and cuts.

ORNAMENTAL STREET LAMP POSTS.

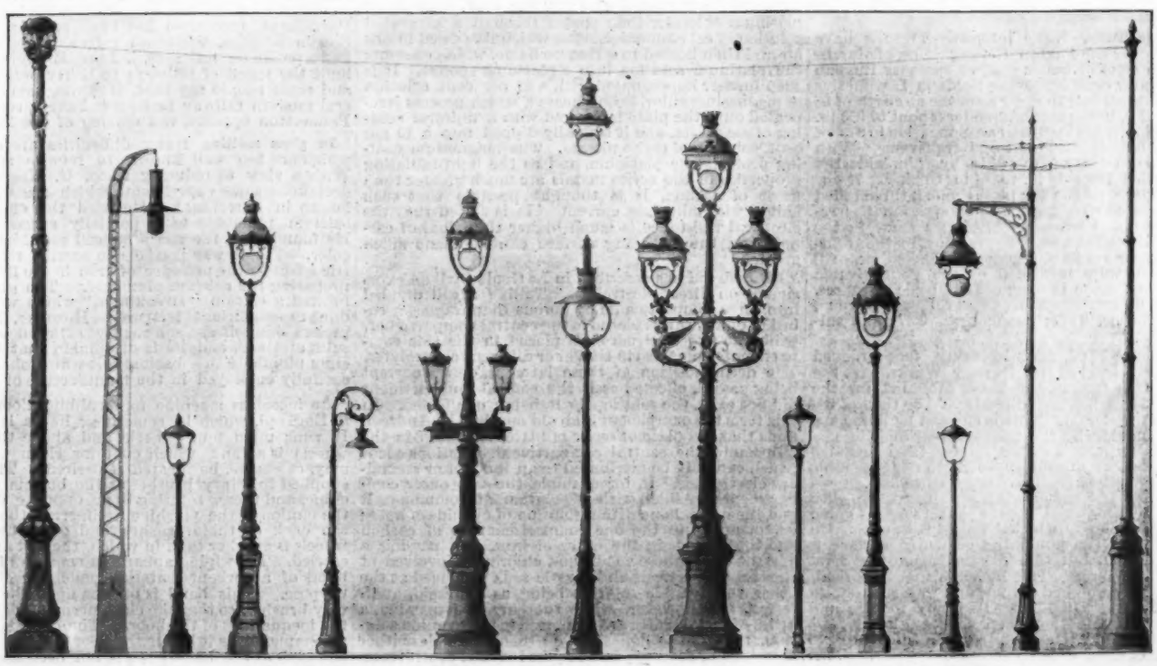
THE ordinary gas lamp post is certainly not a thing of beauty, especially when it is adorned with a mail box. With the advent of the electric light, it was thought that the posts for supporting the lamps would be more ornate. In many instances this has been the case, but in too many of our cities and towns the lamp posts with wide extending arms look even worse than the old time ones.

There have, however, been some notable exceptions to this state of things, notably on Fifth Avenue, New York, where some quite ornamental posts have been erected.

In Europe, however, the metal post is very largely used, and it must be said that they are usually in excellent taste, and, of course, add greatly to the appearance of the city. We present an engraving of some French posts. The ornate column on the left is a form which has been adopted by the city of Toulouse, the lamp itself being suspended over the middle of the street. The second post on the left of the engraving is intended for railway stations, or where the appearance is a matter of small consequence. The third is a simple but effective design of a post for incandescent lamps. The fourth is the form adopted by the city of Paris for certain classes of lighting. The fifth, looking something like a shepherd's crook, is a post used at Perpignan. The sixth is a handsome post which is used in the Place de l'Opéra in Paris. The seventh post is used in Marseilles, while the eighth, with three lights, is also used in Toulouse.

Such posts are, of course, expensive, but add greatly to the monumental appearance of a city. The ninth post is used in Paris for incandescent lighting. The design is particularly pleasing. The next is used in the abattoirs at La Villette, Paris. The three remaining posts are in use in other cities. The one which carries the cross arms for supporting the wires is particularly effective. In one place, at least, in Europe, the posts are arranged to drop out of sight into wells provided for them, so that they will not be out of keeping with the historic buildings of the celebrated square.

Equally handsome posts to those we illustrate are made in America, but their use is not so general.



ORNAMENTAL STREET LAMP POSTS.

ENGINEERING NOTES.

Divers have been engaged to recover 1,700 tons of steel rails which were recently dropped into the river at the Edgar Thompson Steel Works at Braddock, Pa., by the collapse of two flat deck boats.

It is said that the longest artificial watercourse in the world is the Bengal Canal, in India, which is 900 miles long. The next longest is the Erie Canal, which is 363 miles long; each cost nearly $10,000,000.

The iron gates of the Danube have been broken down by the recent completion of the navigation canal cut through the solid rock on the Servian bank from Orsova downward, into which the waters of the river have just been admitted. Vessels will not be admitted till the obstructions in the river bed below the rapids have been removed. The formal opening will be made by Emperor Francis Joseph, on September 27, during the Hungarian millennium festivities.

France's fastest express trains are: On the Nord Railway, the Paris-Lille train, whose speed, excluding stops, is 52¾ miles an hour; the Calais express makes 51 miles; on the Est, Orleans, Paris-Lyon, Mediterranée, and Midi Railways, the trains from Paris to Nancy, Bordeaux, and Marseilles and from Bordeaux to Cette, whose speed is 45½ miles; and on the Ouest line, the Paris-Havre express, making 41½ miles. The law of 1853 limiting the extreme speed at any point to 75½ miles an hour is still in force.

The Belgian government has let the contract for the construction of a ship canal from Heyst to Bruges, which will make that town a seaport. The total cost of the work is placed at about $7,800,000, of which all will be contributed by the state, with the exception of $1,000,000 which will be paid by Bruges, and about $1,100,000 which will be furnished by a company which will eventually take control of the port, the canal and the dock. The navigation of the canal, which is six miles long, will be free. Various dues and charges will be fixed by the Belgian government.

The engineers of the Marquette Iron Range Railroad have been considering a scheme for utilizing the power of a loaded train going down grade. It is proposed to string a trolley line over the track, which falls some 800 feet in 15 miles. The ore cars are to be made up into trains of ten cars each, each car carrying 25 tons of ore. A motor car will be attached to each train and in it will be placed a dynamo connected with the axle of the car. The descent of the train will cause the generation of the electricity, which will be transferred to the trolley line and used for power by the motor car of the ascending train, which will haul back the empty cars.

It is stated that the Japanese government has arranged for the establishment of a steel foundry in Japan, by Sir W. G. Armstrong & Company, Limited, on condition that the material shall, for the present, be imported from England; that 80 per cent. of the workmen shall be Japanese and 20 per cent. be brought from England; that when a new arm is invented in England it shall be manufactured at the works in Japan; that for a stated number of years the Japanese government shall give a fixed subsidy to the company. On the expiration of the period during which the company receives the subsidy, the works shall be sold to the Japanese government.

A case of remarkably rapid bridge erection is mentioned in a recent issue of the Engineering Record. It was accomplished at a crossing of the Snake River, on the Oregon Short Line, formerly a division of the Union Pacific Railroad. The bridge gang arrived at the site on the evening of January 24. Work was immediately begun on the traveler and falsework for the three west spans, each of 217 feet center to center of end piers. The three spans were erected, floor system in, and ties and guard rails finished on February 8, making a total of 12 working days in which the entire work was done of putting in falsework, removing the old Howe truss spans, and erecting 660 feet of new bridge. The spans were of the design known as the Pegram truss. The last span was erected in 5 hours and 20 minutes. The work comprised in the erection means taking the iron from the yard, raising the trusses, and driving all pins, but does not include putting in the floor system.

Boiler Plate Tests.—Some interesting results have been obtained by the Paxton Rolling Mills, of Harrisburg, Pa., on tests of boiler plates for twenty Russian locomotives now building at the Baldwin Locomotive Works. The steel had to show a tensile strength of 35 kilos. to 42 kilos. per square millimeter (about 50,000 lb. to 60,000 lb. per square inch) and an elongation in 8 in. of 25 per cent., both longitudinal and transverse. With the exception of twenty plates ⅝ in. by 87 in. wide, the material varied from ½ in. to ¾ in. thick by 74 in. wide and under. Of the 104 plates rolled, three failed in tensile and one on gage. In elongation the remaining 100 plates averaged 27·46 per cent. in the longitudinal direction and 27·90 per cent. in the transverse—the latter result not generally looked for. All the steel slabs were furnished by the Pennsylvania Steel Company, made in open-hearth basic furnaces, and showed an average analysis as follows: Carbon, 0·165; phosphorus, 0·014; manganese, 0·37; and sulphur, 0·27.

A new method of manufacturing facehardened armor is being tried at the Pannier Works, says the Iron Age. One face of the ingot intended for the armor plate is carbonized directly at the time of being run into the mould. This is effected by lining one wall of the mould with the necessary carbonizing material, which must, it is stated, be free from occluded gases, and of great durability, so as to remain stable during the process of casting. Experience has shown that the amount of cementation obtained varies with the carbonizing material used, about twice as much effect being obtained with charcoal as with coke. On withdrawal from the mould the cemented surface is slightly wrinkled, but this disappears in the after working of the ingot. The heaviest ingot yet dealt with in this way weighed 3 tons, and was reduced in its initial thickness of 16 in. to 4 in. by forging and rolling. An examination then showed that for 1·5 inches from the face the metal contained 1·78 to 1·50 per cent. of carbon, which decreased regularly to between 0·25 and 0·15 per cent. at the back of the plate.

ELECTRICAL NOTES.

Experiments are being made in London with paper pulp water pipes, the object being to provide a pipe which will be unaffected by electrolysis from electric railway return currents.

It is stated that in St. Petersburg sleighs are being built which are to be driven by electricity. The problem of the horseless sleigh, however, is more difficult to solve than that of the horseless carriage.

It is well known that the passage of an electrical current from the car wheel to the track increases the adhesion. The latest theory is that the increased friction is due to a slight welding action of the current.

One of the latest developments in electrical therapeutics is an electric poultice pad made of asbestos and kept warm with an ordinary current. It is given the effect of moist heat by covering it with a wet flannel. The old style poultice was objectionable on account of the frequent changes of temperature incident to its renewal. This is entirely avoided in the present device.

There would appear to be a good opening for the use of electric heating in the drying of fruit. The process of drying necessitates the greatest possible care, as at a too high temperature the fruit will be damaged. Steam heated drying rooms are often used, but the system is not very satisfactory when worked on a small scale. With electric heaters perfect regulation can be obtained.

According to Electricity, a striking illustration of the extension of telephone service by low rates is furnished at Shelbyville, Ind. Here the Mutual Telephone Company is maintaining an independent service of 225 subscribers at $1 per month in face of strong opposition from the local Bell company. In addition to the cheap rates in the city, the country people have taken the matter up, and the entire south side of the county is now connected with telephones. A company consisting of three men was organized; they purchased instruments, went into the woods and cut poles, purchased wire at wholesale, and, by doing their own constructing, put up one of the cheapest telephone systems in the country.

With a view to ascertaining the highest speed at which telegraphic characters can be legibly recorded, says the Electrical Engineer, Mr. P. B. Delany in some recent experiments succeeded in transmitting by his machine system 8,000 words per minute, and obtained a plain reproduction of the signals by electrolysis on the chemically prepared receiving tape. The circuit was an artificial one of 650 ohms, 2·95 microfarads, and the electromotive force was 115 volts. This is about the equivalent of an ordinary telegraph line of 100 miles in length, or, say, New York to Philadelphia. At this speed the perforated tape upon which the messages were composed passed through the transmitting machine at the rate of 27½ feet per second, and the impulses comprising the letters traveled at the rate of 2,500 per second or 133 words, equal to six ordinary telegrams of 22 words each in a single second.

M. Marcellin Berthelot, in Ann. Chim. Phys., states that he has formerly shown by experiment that in the electrolysis of an alkali salt, of which neither the acid nor base is oxidized or reduced during the operation, the minimum E. M. F. necessary for electrolysis is the sum of two equivalent quantities—the one being the heat absorbed in the separation of the acid and the base in dilute solution, the other the heat of decomposition into oxygen and hydrogen of the water holding the substance in solution. In the case, for instance, of potassium sulphate in dilute solution the sum of the two quantities of heat is 15·7 + 34·5 = 50·2 cal. when one gramme of hydrogen is liberated. This is equivalent to 2·20 volts, a number which Le Blanc has obtained by direct observation. Other results are quoted in support of the above law, which the author maintains as an empirical law, independent of any hypothesis regarding the condition of the dissolved salts in solution.—Progressive Age.

It is proposed to use for incandescent electric lamps a filament made of hygroscopic asbestos paste, says the Colliery Guardian. This, after being prepared in the form of a paper 0·3 mm. thick, is cut into strips 6 cm. wide and impregnated with a 30 per cent. solution of platinum chloride, then passed through a saturated solution of sal ammoniac, after which it is dried in hot air and then heated in a Bunsen flame, which converts the platinum solution into a platinum sponge. It is then further impregnated with a 20 per cent. solution of magnesium chloride and heated, which process is repeated until the plate is covered with a uniform coating of magnesia, and it is finally dipped into a 10 per cent. solution of cerite nitrate. The magnesium coating protects the platinum, and as the light-radiating properties of the cerite metals are much greater than those of carbon, it is thought possible that such lamps will take less current. It is stated that the electrical resistance is much higher than that of carbon, and the radiating surface can be made much greater.

M. Andreoli has described in Le Genie Civil an experiment on direct electrolysis. Taking a cell divided into three compartments by porous diaphragms, a solution of any salt is placed in the central compartment, while the two electrodes are placed in the side compartments immersed in similar or different electrolytes. The decomposition of these latter is, on the current being passed, effected as if the central compartment did not exist, the solution in it being unaffected. In this form the experiment is an old one, but M. Andreoli finds that if a plate or series of plates is placed in the solution in the central compartment, reactions occur which can only be attributed to an indirect or secondary electrolysis. If, for example, the two outer compartments are filled with a solution of common salt and the central one with a solution of cyanide of gold; let the anode in the one compartment be of carbon and the cathode in the other of iron. On passing a current under these conditions, chlorine is evolved at the carbon electrode and caustic soda produced at the other, the cyanide solution being, as aforesaid, unaffected. If, however, while the current is passing, a series of metal plates are immersed in the cyanide solution, the gold is deposited on them, though neither chlorine nor soda appears to pass into the central compartment.

MISCELLANEOUS NOTES.

The record for nigh speed has again been broken, this time by one of the new class of torpedo boat destroyers for the British Navy. On her recent trial the Desperate, built by Thornycroft & Company, London, averaged a speed of 31·035 knots an hour on four consecutive runs. This is close upon 36 miles an hour.

The European Economist publishes some facts with regard to the growth of population in the various countries of Europe during the decennial period 1885-1895. The aggregate increase was 29,922,800. Some states have advanced greatly. For example, Russia added 12,510,800 to her existing population; Germany 4,522,600; Austria-Hungary, 3,502,200; Great Britain 2,452,400; Turkey, 1,100,000; and France, 67,100.

From the Newspaper Press Directory for 1896 it appears that there are now published in the United Kingdom 2,355 newspapers. Of these there are 1[illegible] daily papers published in England, 7 in Wales, 19 in Scotland, 18 in Ireland and 2 in the British Isles. On reference to the first edition of the directory for the year 1846 we find the following facts, viz., that in that year there were published in the United Kingdom 551 journals. Of these 14 were issued daily, viz., 12 in England and 2 in Ireland.

A statistician has figured out that, taking the statistics for the last ten years as a basis for the average, there are 1,250,000 lawsuits brought in England every year, 750,000 in France, 1,400,000 in Italy and 3,000,000 in Germany, while the United States stands at the head with a record of 5,500,000. It is estimated that the eleven district courts in the city of New York for the disposal of civil cases only have before them annually 75,000 cases. Taking the country over, the average number of cases per thousand of population is 7[illegible] to 85.

The most crowded spot on the earth's surface is that portion of the city of Valetta, island of Malta, known as the "Manderaggio," says the Edinburgh Scotsman. In the whole of Valetta, the proportion is 75,000 human beings to the square mile, but in the Manderaggio there is one locality in which there are 2,57[illegible] persons living on a plot of ground less than two acres and a half in extent. This would give no fewer than 636,000 persons to the square mile, or 1,017·6 to the acre. In Liverpool, the most crowded city in Great Britain, the most densely populated portions have only 116·4 to the acre.

The pharmacy of K. J. Ferrein, at Moscow, Russia, is thought to be the largest in the world. As many as twelve hundred prescriptions are put up in one day. The dispensing is done in a glass domed room, where about twenty-four assistants are employed, and a large clerical force is required to take the orders and deliver the goods. If poisonous drugs are used in putting up a prescription, the checking of weights is done by a weigher specially employed for that purpose. The annual number of prescriptions is not far from 300,000. Two hundred and ninety-three men and boys are employed in the wholesale and retail departments of the establishment.

Speaking recently before the Institute of Mining Engineers at Sheffield, England, Mr. F. G. Shaw stated that there was sufficient water power at the Victoria Falls on the Zambesi to meet all demands for power for twenty years to come. The old workings are of great antiquity, and one excavation is 1,000 feet long, 500 feet wide, and 200 feet in depth. He was of the opinion that the original workers were directed by the Phenicians. Work seemed to be carried on in a primitive way, striking stones of tough igneous rock being very numerous where the gold existed on one wall of the reef more than the other, and the auriferous quartz has evidently been chipped off by these striking stones.

Some mistakes made by great Englishmen in their attempts to guide the course of engineering development are mentioned by Sir B. Baker in his presidential address, delivered at the Institution of Civil Engineers. Smeaton did not consider Watt's steam engine of any importance. Telford thought the Liverpool and Manchester Railway would be of small use. Sir Robert Peel, by action in Parliament, prevented the building of a central station in London, where all railway lines would have had a common terminus. Lord Brougham tried to limit the speed of railways to thirty miles an hour, and some people say that, if Brougham failed, several modern railway managers have succeeded. Lord Palmerston opposed the cutting of the Suez Canal.

In glass melting many difficulties are experienced which are too well known to require specification. With a view to reducing them, G. Kastner has undertaken some experiments which are described at length in Sprechsaal. He tried the effect of using calcium plumbate with partially successful results. He found that the gas produced acquired a greenish color. Yet it was possible to ascribe this calorimetric effect to the presence of iron in the lime used for preparing the calcium plumbate. The glass also exhibited a certain "streakiness," which was probably due to insufficient mixture. However, Kastner expresses himself as sufficiently satisfied with the results attained, and he is of opinion that besides calcium plumbate the barium salt will probably be successfully employed in the manufacture of glass.

An ingenious machine for scrubbing floors is in use in England, which is something like a lawn mower. It runs upon four wheels, and above the two front wheels is a tank which contains clean water, which may, of course, be heated if desired. The water is supplied to rotary brushes at the bottom of the machine, and these, rotating in an opposite direction to the motion of the machine itself, scrub the floor. At the back of these brushes and over the two back wheels is another tank in which the dirt and water is carried. The wiping apparatus consists of an endless band of absorbent material made especially for the purpose. This band is pressed upon the floor by rotary brushes, so that the cloth accommodates itself to the inequalities of the floor. The cloth is rinsed out mechanically as it leaves the floor and passes through the tank at the back. It is not necessary to sweep the floor before scrubbing.

CHEAP GAS AND COKE FOR BOSTON AND SUBURBS.*

I AM, Mr. Chairman and gentlemen, as you very likely know, the president of the Dominion Coal Company. Our mines are located in the island of Cape Breton, in the province of Nova Scotia. There are abounding fields of coal there.

Our coal is of a highly volatile character, and it is exceedingly smoky. Well, now, what does that mean? Why, it simply means that it is rich in gas and it is rich in tar, both valuable by-products. It is, furthermore, rich in ammonia. It contains ammonia which contains about five pounds of nitrogen for every ton of coal. The thing that we ask leave of you to do is to bring that coal from Cape Breton in its raw state, resolve it into its constituent elements of coke and tar and gas and ammonia and supply them for the various needs of your people.

There is at Johnstown, Pa., a bank of sixty coke ovens built by the Cambria Iron Company, on the Otto-Hoffmann system, where the whole of the latest German process can be seen. The literature on the by-product subject has increased very much during the last year.

As good a description as I have seen anywhere of this oven is found in a book published by Dr. F. L. Slocum, of the Gas Engineering Company, of Pittsburg, a man who ranks at least as high as any man in Pennsylvania as an expert on coke and gas matters, and who is consulted and has been consulted for years by the men who manage those large industries in that great center. Dr. Slocum made a special visit abroad two years ago, in connection with Mr. Weeks, the editor of the American Manufacturer and Iron World, for an examination of this subject. The pamphlet reads as follows:

The chief processes of dry distillation of coal now in use are the following: First, the manufacture of illuminating gas, by which a good gas, but inferior and little coke, inferior tar and less ammonia, are produced, and this in a very expensive way; second, the ordinary coking process in beehive ovens, by which only a good coke is produced, while all the other by-products go to waste; third, the improved coking process in retort ovens, by which all the products are obtained in satisfactory quality and quantity.

Among the different retort coke ovens with the recovery of by-products, the Otto-Hoffmann oven has given the best results and is the most universally adopted.

The process is as follows: The coal is coked under perfect exclusion of air, in long, rectangular ovens or retorts of fire brick (33 feet long, 6 feet high, and from 16 to 26 inches wide, according to the character of the coal). They are closed at both ends by iron doors. All the gases and vapors then enter the large collecting main, and pass through the same into the condensing house, where they are deprived of tar and gas liquor. The gas liquor is afterward pumped into the ammonia house, and there converted into sulphate of ammonia or concentrated ammonia liquor.

After leaving the condensation house, the purified gas enters the holder, from which a part of it is returned to the ovens to be burned in a system of flues within the side walls and under the bottom of the retort. The amount of gas used to heat the ovens varies, with the character of the coal, from 40 to 60 per cent. of the total gas; the rest is available for other purposes.

The enormous quantity of gas is evident from the following figures. A plant of 60 Otto-Hoffmann ovens, running on Connellsville coal, produces 3,822,000 cubic feet of gas per 24 hours, of which at least 1,911,000 cubic feet are available for general commercial purposes.

There is very little difference between coal gas from gas retorts and coke ovens. In case the gas is to be used as a fuel, it will require no further treatment. If it is to be used as an illuminant, the sulphureted hydrogen would have to be removed, and the gas would have to be enriched.

TABLE OF ANALYSES AND RELATIVE HEAT VALUE OF DIFFERENT GASES.

	Murraysville Natural Gas.	Illuminating Av. American.	Cologne (Ill.) Gas.	Otto-Hoffmann Oven Gas.	Water Gas.	Producer Gas, Bituminous coal.
Benzole vapor, C_6H_6	....	....	1·54	0·61	....	....
Ethylene, C_2H_4	1·0	4·0	1·19	1·43	....	0·4
Acthane, C_2H_6	5·0	....	....	....	....	....
Marsh gas, CH_4	67·0	40·0	36·0	36·11	2·4	2·5
Hydrogen, H	22·0	46·0	55·0	53·32	45·0	12·0
Carbon monoxide, CO	0·6	6·0	5·4	6·49	45·0	27·0
Carbon dioxide, CO_2	0·6	0·5	0·87	1·41	4·0	2·5
Nitrogen, N	3·0	1·5	....	....	2·0	56·2
Oxygen, O	0·8	0·5	....	....	0·5	0·3
Sulphureted hydrogen, H_2S	....	....	....	0·43	....	....
Vapor, H_2o	....	1·5	....	....	1·5	....
Relative heat value	100·0	74·0	74·0	70·6	37·4	19·4

Note.—All figures per cent. of volume.

There is one product of these by-product coke ovens (ammonia) which is exceedingly valuable to our agricultural industries. Dr. Bruno Terne, in a paper before the chemical section of the Franklin Institute, October 20, 1891, said:

The consumption of ammonia in its various forms has grown enormously in the last twenty years, and the manufacture of illuminating gas is not longer sufficient to supply the increasing demand for ammoniacal liquors. On the other hand, the inroad which electrical plants for illumination have been making yearly on the production of illuminating gas has already been felt, and will be more so from year to year. The production of water gas and oil gas are other factors that are cutting down the amount of ammoniacal liquors produced.

But there is another source for tar and ammonia, which, so far as my knowledge goes, has, with a single exception, not been worked in our country. I refer to the production of tar and ammonia as a by-product of the manufacture of coke.

If you will visit our coal regions to-day, you will find the nightly sky illuminated from the fires of the coke ovens, and every one of the brilliant fires bears testimony that we are wasting the richness of our land in order to pay the wiser European coke manufacturer, who saves his ammonia and sends it to us in the form of sulphate of ammonia, and who also saves his tar, which, after passing through the complex processes of modern organic chemistry, reaches our shores in the form of aniline dyes, saccharin, nitrobenzol, etc.

The purpose of my presence here to-day is to point out to you how this waste can be saved and preserved and handed over to your people as gas, and so much cheaper than they ever had it before.

Let me, before I enter upon the subject of gas, refer to the importance of ammonia. I find from Prof. Goessmann, of the Agricultural Experiment Station at Amherst, which keeps in close touch with the value of commercial fertilizers, that he has made tests (66 I think he said in all) of manures in various parts of this State, to determine exactly what the manurial value in nitrogen, potash and phosphorus was as it is put upon the ground. These are the results:

Nitrogen $\frac{1}{4}$ of one per cent. equals 8 lb. at 12c. per lb.; total value	$0.96
Phosphoric acid, $\frac{1}{8}$ of 1 per cent., or 4 lb. at 5c. per lb.; total value	0.20
Potash, $\frac{1}{8}$ of 1 per cent., or 6 lb. at 4½c. per lb.; total value	0.27
Total value of one ton of manure	$1.43

Therefore, if you were to buy commercial fertilizers containing the same amount of plant food that is found in a ton of manure, you would pay for it $1.43. Prof. Goessmann says that the manurial value of an animal for one year, estimated on a consumption of 25 pounds of food per day, is two and a quarter times $1.43, and that is $3.22, to be exact.

The professor tells me that, in order to produce good crops, there should be the equivalent of four or five tons of manure to every acre, or better still, six tons. The importance of this matter to which I am calling your attention to-day is this, that with every tone of bituminous coal that is burned to-day there is the equivalent of 25 pounds of ammonia, which is the equivalent of five pounds of nitrogen, and at the same value which is reckoned here as manure, there is a money value of 60 cents. The waste in every six tons of coal which is burned throughout the whole of New England, of bituminous coal, is equivalent to the manurial value of an animal for a year. Now what does that mean with reference to the agricultural industry of Massachusetts, if all this nitrogen could be saved and placed upon your soil? It means that in this 6,000,000 tons of coal that are burned throughout New England to-day there is a manurial value of a million of cattle.

I know of nothing more hopeful for the agriculture of this State, nor of New England, nor of the whole of this broad land, than that capitalists are turning their attention to-day to the extraction of this great amount of nitrogen which is needed for your exhausted soils. It means, of course, that throwing such a large amount of nitrogen upon the market will cheapen its cost, and that is the advantage of it. Since 1882 to 1894, for 12 years, it ranged from $90 a ton. The lowest price was about $60. To-day it is selling for $60 a ton to the farmers. The people in Johnstown told me that they were receiving $52 a ton. Mr. Chairman and gentlemen, every man who is familiar with the necessities of agriculture at this day, and understands what the cheapening of nitrogen means, understands what a great benefit it will be to these people, the saving of these by-products.

It will be observed, Mr. Chairman and gentlemen, that none of these gentlemen that I have quoted heretofore with reference to this matter lay any stress at all upon the value of the gas. It is the tar and the ammonia that they are seeking to save, which are exceedingly valuable by-products. But here gas has a high commercial value. To-day the general price throughout the State of Massachusetts, exclusive of the city of Boston, is $1.50 a thousand. That is what the people have to pay to-day outside of the city of Boston and one other city, which is the city of Lowell.

GAS STATISTICS OF MASSACHUSETTS FOR 1894—BIGEST FROM GAS COMMISSIONERS' REPORT.

	Gas sold. Feet.	Price, per 1,000 ft.	Population.	No. families to one meter.
Adams	3,882,460	$2 33	7,837	11·90
Amesbury	4,073,075	1 88	9,986	10·25
Arlington	6,001,900	2 50	15,508	6·25
Belmont				
Winchester				
Brockton	15,768,700	1 90	38,165	6·00
Haverhill	53,753,000	1 40	34,945	2·50
Bradford				
Lowell	256,591,500	1 06	90,189	2·00
Dracut				
Tewksbury				
Marblehead	3,039,640	2 68	7,671	6·80
Salem	34,393,000	1 60	44,980	3·40
Springfield	90,067,000	1 40	51,522	2·17
Webster	1,583,300	2 50	11,002	14·75
East Boston	42,425,000	1 60	42,503	4·40

Take, for instance, in the first place, Adams. Adams sold in 1886—which, I think, was the first year—4,847,660 ft. of gas at $2 40 a thousand. There was at that time a population in Adams of 8,283, or 1,657 families (reckoning five to a family, which is the basis of all these calculations). Of that number, 148 used the gas. That was in the proportion of 11 to 1. In 1894 the consumption of gas had fallen to 3,882,460. The price had fallen 7 cents in eight years and stood at $2.33, and the number of families taking it at that time was 132, or about 1 in 11·9.

In Arlington, Belmont and Winchester there were in 1885—and let me say with reference to this matter that the amount per thousand required to pay a dividend (I believe Adams and Amesbury each paid at that time a dividend of 10 per cent.) was 44½ cents a thousand of the gas, and in Amesbury 64 cents. In Arlington, Belmont and Winchester there were, in 1886, sold 4,843,400 ft. of gas at $3. There was at that time 10,702 population, comprising 2,140 families. There were 327 takers in those towns of Arlington, Belmont and Winchester, amounting to one taker to every 6½ of the families.

The city of Lowell, which is the bright exceptional star in this horizon—the city of Lowell, supplying Dracut and Tewksbury, with a population altogether of 90,000, supplies every other family. Their consumption of gas is over 236,000,000 ft.; while Fall River, with a population of 89,203, only sold 67,000,000 ft. and supplied only one family in 7·6.

Now, I suppose that is as fair an illustration as you can have of the effect of cheap gas upon the supply. There is the city of Lowell, supplying every other family, almost—that is, the number of meters in proportion to the whole number of families is almost 1 to 2; and in Fall River—and I suppose the people of Fall River live under very similar conditions to those of the people of Lowell—the number of families who have gas—I presume on account of the high prices—is in the proportion of only about 1 to 8. There is a proportion of 1 to 8 in Fall River, as compared with a proportion of 1 to 2 in Lowell.

I am surprised, as I look at these statistics, that any well managed gas company familiar with these conditions should have allowed this condition of things to exist; for I hold that these companies, like all quasi-public corporations, owe to the community to keep abreast of the state of the art in all countries. It does not answer for them, nor for any other corporation holding quasi-public rights, to rest upon their laurels and make no improvement in their condition, nor seek to supply the people who are not now using gas, and whom they ought to have supplied for the last thirty years.

Mr. Chairman and gentlemen, it is known to every gas man and it is known to many other people that gas in foreign cities is furnished at a very much cheaper price than it is in the United States. You have heard references to the experience of Manchester, Glasgow, Birmingham and many of the other leading cities of Europe, where municipal governments control these different franchises. But I am happy to say, from the investigation that I have made, that, notwithstanding the fact that gas is cheap in these places, yet the gas supplied by the large private companies is in price not unequal to the prices charged by the municipalities.

Here, Mr. Chairman and gentlemen, is a publication made every year, entitled "An Analysis of the Accounts of the Principal Gas Undertakings in England, Scotland and Ireland for the Year 1893." I have not been able to get a later report. Here are the principal gas undertakings, of which I have the following table compiled from this publication:

GAS STATISTICS OF GREAT BRITAIN.

	Population.	Number of consumers.	Output, Cu. ft.	Price per 1000.	Candle power.
Municipal corporations.					
Birmingham	500,000	58,053	4,222,067,000	2s. 5d.	17·28
Bolton	115,000	28,566	783,360,000	2s. 8d.	17·99
Carlisle	39,000	6,301	228,300,000	2s. 3d.	19·16
Leicester	142,000	25,836	1,125,641,000	2s. 4d.	16·65
Manchester	505,000	81,453	3,636,680,000	2s. 6d.	19·11
Nottingham	211,000	38,005	1,502,510,000	2s. 5d.	19·00
Oldham	131,000	44,787	871,177,000	2s. 3d.	19·50
Salford	198,000	28,005	1,111,796,000	2s. 4d.	18·54
Private companies.					
Bath	50,844	7,463	396,003,000	2s. 8d.	16·00
Brighton	115,873	17,439	962,826,000	2s. 0d.	14·57
Bristol	221,578	32,600	1,578,956,000	2s. 10d.	16·56
Derby	94,146	14,900	446,869,000	2s. 7d.	16·50
Liverpool	517,980	73,200	3,391,873,000	3s. 0d.	21·59
Newcastle-on-Tyne	186,300	30,144	1,965,233,000	1s. 8d.	16·00
Plymouth	84,348	10,722	668,588,000	1s. 9d.	14·50
Portsea	159,278	10,400	649,911,000	2s. 4d.	14·82
Preston	107,573	23,283	403,739,000	3s. 1d.	18·75
Sheffield	324,243	48,956	1,874,700,000	1s. 10d.	17·88

THE MANUFACTURE OF BESSEMER STEEL.

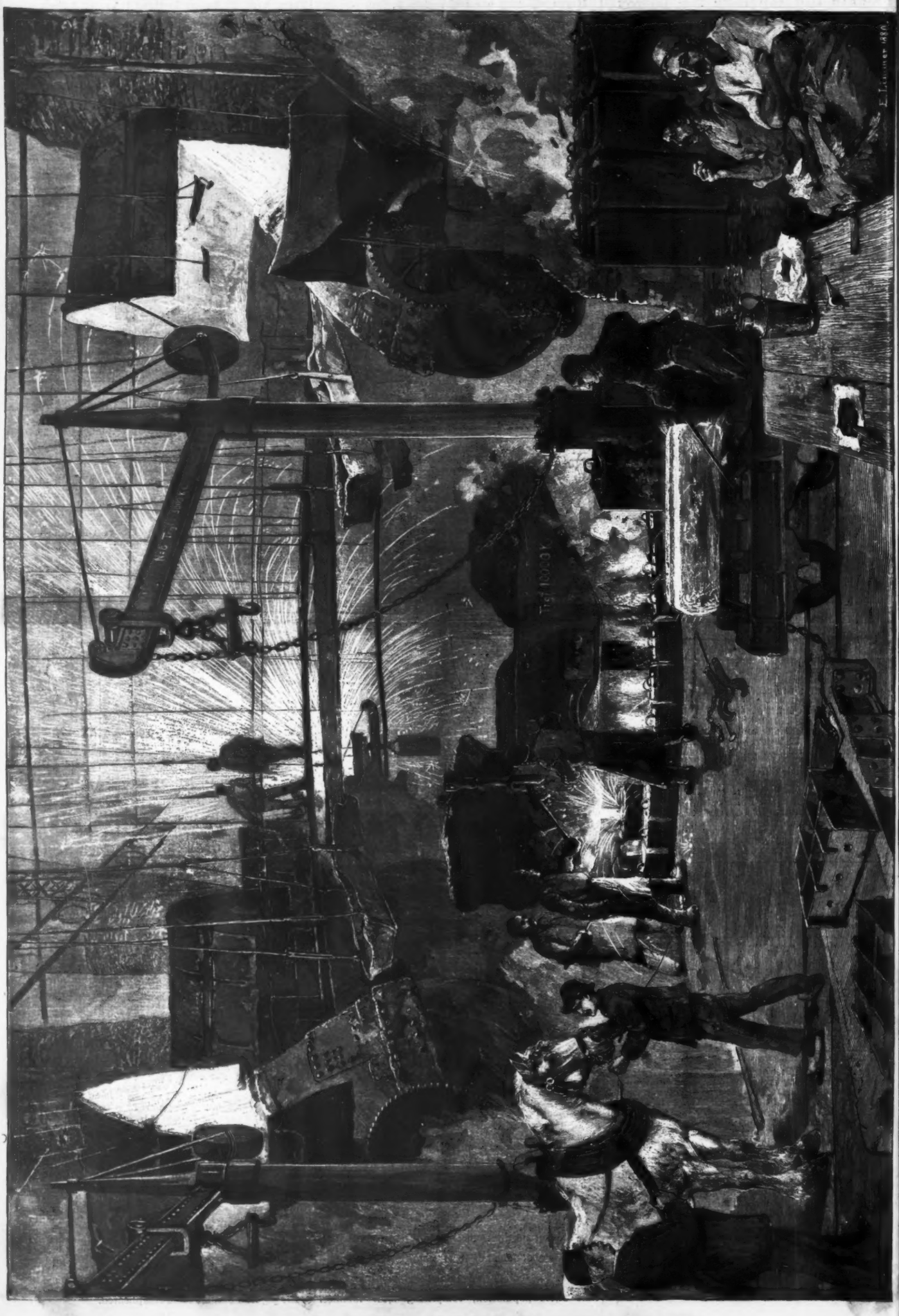
THE Bessemer process for the manufacture of steel is one of those modern inventions which have caused human progress to advance by leaps and bounds in this remarkable nineteenth century. Its introduction caused a large and rapid increase in the production of steel, and enabled the manufacturers to turn out a high grade material in less time and at less cost.

Henry Bessemer, the author of the process which bears his name, was a prolific inventor, and his patents for processes in steel manufacture were only a part of a large number which were granted him for a variety of inventions. The famous Bessemer process, which has brought him more fame and wealth than all the rest together, is described in his specification of January 4, 1856, as aiming at "the more perfect and complete refinement of the iron, whereby it gradually loses the properties common to pig or crude iron, and acquires the properties of cast steel, or of a pure or decarbonized iron, while it still preserves such a state of fluidity as will admit of its being cast into ingots or other desired forms." Again, in his specification of October 17 of the same year it is stated that "the steam or air will force its way to the surface, producing considerable agitation of the melted metal, and this in turn exposing every part of it to the chemical action of the gaseous products passing through it, the oxygen of the air or decomposed steam absorbing rapidly the carbon of the iron, and carrying it off, as also the sulphur and other volatile matters."

The process as here outlined is mainly the same as that in use to-day; although in the later stage it has been modified by the addition to the metal of a certain amount of a special cast iron known as spiegeleisen.

In the early days of the manufacture of pig iron, the iron ores which were used were very nearly pure oxides, and for smelting a fuel was used that consisted mainly of pure charcoal. The resulting pig iron was a compound of iron and carbon. Steel was obtained from wrought iron by introducing a certain amount of carbon, and wrought iron by puddling or other process until practically all the carbon was removed. With the introduction of impure ores, and the use of coal in place of charcoal for smelting purposes, the composition of the pig iron became more complicated.

* Digest of the testimony of Mr. Henry M. Whitney before the Legislative Committee on Manufactures.



The sulphur of the coal, for instance, began to show itself in the pig, together with other impurities derived from the ores. Some of the earlier specimens of Bessemer steel, when forged on the anvil, cracked and broke to pieces; and upon subjecting them to chemical analysis it was found that, though the silicon and most of the carbon had been removed by the air blast, nearly all of the sulphur and phosphorus which had been in the pig iron was still remaining in the steel. This led the British manufacturers to make use of hematite pig, which contains a large percentage of carbon, but a relatively small amount of phosphorus and sulphur. The difference in composition between a good grade of Cleveland pig and hematite pig is shown in the following table, which was drawn up by Mr. W. M. Williams from specimens of the two varieties—the composition of the hematite being the average of thirteen brands which were made for the manufacture of Bessemer steel in the year 1870:

	Cleveland Pig.	Hematite Pig.
Carbon	1·80	3·188
Silicon	2·23	2·840
Phosphorus	1·30	0·081
Sulphur	0·27	0·139
Manganese	0·71	0·900
Iron	93·69	92·852
	100·00	100·00

It will be noted that the hematite has a high percentage of carbon and a relatively small percentage of phosphorus and sulphur. Under the action of the "blowing" in the Bessemer process the carbon, silicon, and manganese are readily burnt out of the metal, and the amount of phosphorus and sulphur is so much reduced as not to injuriously affect the quality of the steel.

The following table shows the actual composition, by test, of a quantity of pig iron before melting and at the conclusion of the blowing:

	Before melting.	After blowing.
Carbon	3·570	0·190
Silicon	2·260	a trace
Sulphur	0·107	0·093
Phosphorus	0·073	0·070
Manganese	0·410	a trace

It will be seen that, during the fierce combustion which takes place in "blowing," the silicon and manganese have been practically all burnt out, and the sulphur and phosphorus slightly reduced. At the same time the percentage of carbon remaining is too low. To increase the proportion of carbon a certain amount of molten spiegeleisen—a grade of special pig iron which is very rich in carbon and manganese—is poured into the converter, until the right proportion of carbon for the desired quality of steel has been obtained.

The value of the Bessemer process consists in the ability with which it can handle proper grades of pig iron in large quantities, and the speed with which the process is carried through as compared with the earlier methods. In the old process the cast iron was melted in a furnace and air was blown upon the surface of the iron, which was meanwhile turned over so as to expose all parts of the mass to the action of oxygen. This was necessarily a slow process. Bessemer conceived the bold idea of blowing the air under pressure clear through the whole mass of the metal, thus producing a violent agitation and bringing every particle of the iron into searching contact with the active oxygen.

We present a very graphic illustration, for which we are indebted to Black and White, showing the interior of a Bessemer steel works. As will be seen, the plant is very massive, as it needs must be when as high as 10 and even 15 tons of molten metal are handled at one time. To the right and left of the picture will be seen the huge converters, in which, as their name implies, the cast iron is converted into steel by the action of the air blast. The converters are lined iron vessels, which ordinarily will contain from 5 to 6 tons of metal at a charge. These are suspended upon trunnions upon which they have an oscillating or tipping motion, the same being controlled by gear which is seen attached at the sides of the converters. The bottom is freely perforated with a number of holes, through which a blast of air is forced at a pressure of 20 pounds to the square inch. The air passes up through the body of the metal, and, combining with the carbon, silicon, etc., it produces a fierce combustion which serves, as claimed in the original patents, to remove these constituents from the iron, and to raise the whole mass to a fierce heat.

The operation of "blowing" lasts for from 20 to 30 minutes; and the rush of the burning gases from the mouth of the converters during this time is a most beautiful and striking spectacle. After the desired amount of spiegeleisen has been added the steel is cast into "ingots."

In the whole range of the arts and manufactures there is perhaps no sight which is more weirdly beautiful than the interior of a Bessemer works when it is running in full blast.

THE PRINCE OF WIED'S YACHT ALUMINIA.

PRINCE OF WIED'S YACHT ALUMINIA.

WE publish herewith an engraving of the Aluminia, a yacht recently built for the Prince of Wied, by Escher, Wyss & Company, of Zurich, which gave most satisfactory results during its trial trips on Lake Zurich and on the Gulf of Genoa, its future home. As the hull—which is divided into five watertight compartments—and the frames are made of aluminum the vessel is very light, and, of course, the lighter a vessel is the faster it will travel. Therein lies the advantage of using aluminum, especially where the cost of construction is not of great importance. The Aluminia will generally travel under sail, the naphtha motor in the stern of the vessel being intended only as an auxiliary to be used in case of a calm. The tank, which is also of aluminum, holds sufficient naphtha to run the vessel under full headway for five hours, or a distance of 37 miles, without the help of sails.

In the bow of the vessel there is an elegant and most comfortably arranged little cabin, finished in Indian mahogany and yellow pine. The wooden part of the deck is Indian oak. The little saloon can be changed in a very few minutes to a sleeping room for four or five persons. For protection from storms and high waves, the cabin can be closed airtight by means of rubber strips at the doors, so that it will be like an air bubble, and it will scarcely be possible for the vessel to sink.

The Aluminia was constructed by the marine engineer W. Reitz, and completed under his direction.

For the accompanying engraving and the above data we are indebted to Ueber Land und Meer.

[Continued from SUPPLEMENT, No. 1058, page 16916.]

MOTOR VEHICLE TESTS.

THE ENGINEERS SUBMIT THEIR REPORT OF THE TESTS MADE AT CHICAGO—VALUABLE DATA FOR MAKERS AND USERS ALIKE.

WHEEL EXPERIMENTS.

A SERIES of experiments was made with a view to determine the power consumed in wheel resistance, consisting of axle friction and so-called rolling friction, an effort being made to separate these elements with considerable success.

The method adopted in determining the power consumed in wheel resistance was to drive the wheels while resting on a drum of hard wood whose surface was smooth and which was so heavy as to show no perceptible distortion under the loads imposed, the power being measured at the periphery of the drum by the product of its speed and the tension on the dynamometer to which the axle was connected. In this connection it may be noted, as might have been expected from theoretical considerations, that the total dynamometer pull under uniform motion was found constant at all moderate speeds.

In separating the effect of axle friction from that of other losses, observations were made by suspending a load from the axle of a single pair of wheels by a cradle and noting its deflections, which were multiplied by a long pointing arm, making quite a sensitive cradle dynamometer.

The same cradle loads and axle were used with different wheels, and by comparing deflections under different circumstances an approximation to friction of direct or vertical bearing and friction of side thrust was obtained.

The analysis of loss due to the action of other parts of the wheel than the axle is only relative, and was found by comparing the action of different tires mounted on wheels built up in the same way, having wooden hubs, spokes and fellies.

SEPARATION OF AXLE AND TIRE RESISTANCE.

In the overcoming of axle friction the leverage of the radius of the wheel compared with the radius of the bearing gives a ready method of comparing the values of different mechanical bearings and of lubricants, and in order to appreciate thoroughly the problems involved in wheel resistance, losses due to axle friction must be recognized as separate and distinct from losses due to lack of resilience in the tires and other parts of the wheels. Some writers have assumed that summing axle and resilience losses together under the term "rolling friction" (a hazy term at best) was all that could be done, owing to the difficulty of separating the two. We believe the method adopted in making the separation to be novel and one indicating a line of future experiment in this direction which may be of value.

In discarding, then, the term "rolling friction," as

TABLES.

TABLE NO. 2.—POWER AND DUTY TESTS OF MOTOR VEHICLES.

Vehicle.	No. of run.	Speed in feet per minute.	Pull exerted—pounds.	Horse power exerted at rim of wheel.	Horse power consumed in mechanism.	Total horse power developed in cylinder.	Mechanical efficiency.	Gasoline—pounds consumed per hour.	Gasoline—pounds consumed per horse-power hour at rim of wheel.	Foot pounds at rim of wheel per pound of Gasoline.	Cost per horse-power hour, rim of wheel, cts.	Efficiency. H. P. output. H. P. input.	Heaviest pull exerted—Pounds.	Remarks.
De La Vergne R. M. Co., New York. (Benz motor.)	1	619	37	.70	.71	1.41	.50	3.24	4.63	428,000	9.26		162	Trouble with igniter. Two cylinders in use, one only supplying power. Chain broke. Belt Slipped.
	2	1,000	51.8	1.57	1.40	2.97	.53	4.45	2.83	700,000	5.66			
Duryea Motor Wagon Co., Springfield, Mass. (Own motor.)	1	432	81.8	1.10	.59	1.69	.65	4.01	3.64	545,000	7.28		187	
	2	434	88.5	1.16	.59	1.75	.65	3.78	3.24	623,000	6.48			
Haynes & Apperson, Kokomo, Ind. (Own motor.)	1	376	23.1	.26	.61	.87	.30	5.78	21.8	91,000	43.60		119	
	2	796	39.3	.95	1.28	2.23	.43	5.75	6.04	327,000	12.08			
Lewis, G. W., Chicago, Ill. (Own motor.)	1	353	49.9	.53	.53	1.06	.50	3.29	6.20	319,000	12.40		109	
	2	491	17	.25	.65	.90	.28	3.28	12.8	155,000	25.60			
Macy, R. H., & Co., New York. (Roger-Benz motor.)	1	521	52.1	.83	1.48	2.31	.36	3.22	3.90	515,000	7.80		103.7	
	2	945	87.2	2.50	2.68	5.18	.48	4.90	1.96	1,010,000	3.92			
Mueller, H., & Sons, Decatur, Ill. (Mueller-Benz motor.)	1	423	92.1	1.18	.61	1.79	.66	3.50	2.96	669,000	5.92			
	2	540	42.3	.69	.77	1.46	.47	3.87	5.60	454,000	11.20			
	3	564	38.6	.66	.81	1.47	.45	3.77	5.71	347,000	11.42		135.4	
	4	984	73.4	2.18	1.57	3.75	.58	3.40	1.57	1,268,000	3.14			
	5	1,168	34.7	1.23	1.86	3.09	.40	4.15	3.37	588,000	6.74			
						Total H. P. developed in motor.		Electrical input H. P	K. W. hours supplied batteries per H. P. H. at rim of wheel	Foot Pounds at rim of wheel per K. W. H.			INPUT. Volts.	INPUT. Amp.	Test ended by trouble with bearing.
Morris & Salom, Philadelphia. (Lundell motor.)	1	1,025	25.5	.78	.34	1.12	.70	1.36	1.74	1,138,000	17.4	.57	97	10.5	
	2	2,015	29	1.78	.68	2.46	.72	2.90	1.63	1,215,000	16.3	.61	96	22.5	
Sturges Electric Motocycle Co., Chicago, Ill. (Lundell motor.)	1	370	41	.41	.21	.62	.66	.99	2.42	818,000	24.2	.41	121	35	21
	2	892	42	1.14	.39	1.53	.74	1.94	1.70	1,165,000	17.0	.59		69	21

DETAILS AND DIMENSIONS OF MOTOR VEHICLES.

Vehicle.	Weight (light). Driver, pounds.	Weight (light). Steering, pounds.	Weight (light). Total, pounds.	Wheel base, inches.	Gauge drivers, inches.	Gauge steering, inches.	Radius compressed. Drivers, inches.	Radius compressed. Steering, inches.	Position of drivers.	Nature of tires.	Nature of bearing.	Fuel or energy supplied.	No. of cylinders.	Diam. bore cylinder, inches.	Stroke of piston, inches.
De La Vergne R. M. Co., New York. (Benz motor).	1250	430	1680	66.9	.....	.....	23.7	18.2	Rear	Solid rubber	Roller	Gasolene	1	5.12	6.62
Duryea Motor Wagon Co., Springfield, Mass. (Own motor).	729	479	1208	57.5	55	53.7	22.8	18.7	Rear	Pneumatic	.....	Gasolene	2	4	4.5
Haynes & Apperson, Kokomo, Ind. (Own motor).	829	421	1250	54	55.2	55.5	17.8	17.9	Rear	Pneumatic.	Ball	Gasolene	2	4	4
Lewis, G. W., Chicago, Ill. (Own motor).	900	780	1680	56	46.6	46.5	22.9	16.7	Rear	Solid rubber	Roller	Gasolene	1	5	5
Macy, R. H., & Co., New York. (Roger-Benz motor).	1440	385	1825	67	52	52	23.8	17.9	Rear	Solid rubber	Roller	Gasolene	1	5	7.
Morris & Salom, Philadelphia. (Lundell motor).	1300	390	1650	49	44.2	36.1	19.8	14.2	Front	Pneumatic	Ball	Storage battery	Two motors	.....	.....
Mueller, H., & Sons, Decatur, Ill. (Mueller-Benz motor).	1251	385	1636	73	50.2	47.8	24	18.4	Rear	Solid rubber	Roller	Gasolene	1	5.5	6.25
Sturges Electric Motocycle Co., Chicago, Ill. (Lundell motor).	2085	1450	3535	65	57	57	25.1	23.2	Rear	Solid rubber	Plain	Storage battery	One motor	.....	.....

TABLE A—WHEEL RESISTANCE TESTS.

Number of test.	Nature of Axles.	Nature of tires.	Mean diam. of bearings. Inches.	Radius of wheels loaded. Inches.	Weight of pair of wheels. Pounds.	Total load, including wheels. Pounds.	Pull at tire due to axle friction. Pounds.	Total pull at tire, producing uniform motion.
1	Collinge	Steel	1¼	24.5	68	659	5.4	8.84
2	Ball-bearing	Steel	1¼	21.75	....	452	....	2.86
3	Collinge	Solid rubber	1¼	18.9	75	657	2.64	5.49
4	Ball-bearing	Solid rubber	1¼	24.2	....	645	....	2.36
5	Collinge	Pneumatic (inflated). 1¾ inches	1¼	22.5	67	657	1.78	7.37
6	Collinge	Pneumatic (deflated). 1¾ inches.	1¼	22.1	67	598	....	10.57

indicating a compound action, the losses of power in wheels may result from the following factors:

1. Axle bearing friction.
2. Axle thrust friction.
3. Lack of resilience of tires and other parts of the structure of the wheel.

As noted above, we are unable in the limited range of our experiments to analyze the third factor as we would have liked to have done, and thus the tire determinations involve a possible factor of the resilience of other parts of the wheel. (Resilience is here considered to mean the capacity of an elastic body to store and give out work done upon it.)

Table A gives the actual data and reduced results of the tests. These results may not seem to meet preconceived views, and it may therefore be well to briefly analyze the results in order to indicate what may be deduced from a close consideration of the wheel problem.

ANALYSIS OF WHEEL RESISTANCE.

One naturally seeks an answer to such practical questions as: What kind of a bearing ought I to use? What tire is best suited for certain work? What ought to be the diameter of a wheel for efficient service? And others of like nature. The limits of this report will not permit of more than an indication of the bearing of these experiments upon such questions. The following results may, however, be deduced from a consideration of the above data:

TABLE B—Pulls per 1,000 pounds of total load required to overcome lack of resilience in wheels under examination. (See tests 1, 3, 5 and 6.)

5·23 pounds on steel tire.
4·34 pounds on solid rubber tire.
8·5 pounds on pneumatic tires inflated.
14·6 pounds on pneumatic tires deflated.

Let it be noted that these pulls, being due principally to the material of the tire when the rest of the wheel is well made, are not reduced by leverage, as in the case of axle friction, as the moment used in overcoming the resistance is the same as the moment of the resistance.

As before mentioned, the axle friction, acting as it does near the center of the wheel, is overcome by a pull which is inversely proportional to the radius of the wheel. In order, then, to properly compare axle frictions they should be reduced to pulls at equal distances from the center of the wheel. Deducing, then, from experiments we have:

TABLE C—Pulls 1,000 pounds of load on bearings of Collinge axles reduced to uniform radius of 12 inches. (See tests 1, 3 and 5.)

18·7 pounds with steel tires.
7·2 pounds with solid rubber tires.
5·7 pounds with pneumatic tires.

HOW TIRES AFFECT RESULTS.

The question is naturally asked: What have the tires to do with the result?

This leads to the consideration of what carriage builders call "set" and "gather" in wheels, both being designed to compensate for the distortion of a vehicle in operation. The "set" is a vertical adjustment of the axle, so that when the wheels are under working load the tread of the tire will be horizontal. The "gather" is a lateral adjustment of the axle, so that when the wheels are under average traction they will be parallel to the direction of motion of the vehicle.

In the case of a steel tire, unless the axle and tire adjustment is perfect, there is induced in the axle a side thrust which accounts for the abnormal axle friction shown above with the steel tired wheels used.

In the cases of the solid rubber and the pneumatic tires the tire allows a more or less perfect adjustment to be taken naturally.

The load in tests 1, 3 and 5, Table A, were practically the same and the axles were identical, and in the matter of axle bearing friction the same coefficients apply. Thus with the pneumatic tires the coefficient of 5·7 pounds per thousand at a radius of 12 inches, Table C, represents bearing friction and very little, if any, thrust friction.

Reduced to the radius of the bearing, the friction figures 120 pounds per 1,000 pounds, giving a coefficient of friction between surfaces not too well lubricated of 0·12, which corresponds with the result of well known friction experiments.

The difference between 18·7 pounds on the steel tire wheel and 5·7 pounds on the pneumatic, or 13 pounds, represents the pull per thousand pounds at a radius of 12 inches necessary to overcome the action of side thrust.

Thus the elimination of side thrust is a much greater factor in the reduction of power consumed by the wheels of a vehicle than the reduction of the friction of vertical bearing on the axle.

PROPER DIAMETER OF WHEELS.

In the case of tests 2 and 4, Table A, it was not possible to separate axle friction and resilience, but it seems a fair deduction to draw that with tires eliminating side thrust and with well designed bearings, the power consumed in such a wheel system is principally due to resilience. This leads to the question of the determination of the proper diameter of wheels. The pull required to overcome axle friction varies inversely as the radius of the wheel. This pull may become so small with proper bearings that even doubling the radius will only reduce it a mere fraction, while reducing the radius one half will only increase the pull by a trifling amount.

The pull due to resilience does not depend on the radius. Thus economy points to a diameter of wheel which is not determined by the caprice of the maker or the notion of the purchaser. Elsewhere in this report it will be seen that other elements in the propulsion of a vehicle may outweigh the reduction of pull due to axle friction given by an increased radius of the wheels. The kind of road a wheel is intended to travel over has a bearing upon the subject.

The benefit of the pneumatic tire in reducing the amount of work performed in the driving of a vehicle is treated elsewhere in this report. That it was not found in the friction tests may be disappointing to those who had preconceived ideas regarding the matter.

ENERGY EXPENDED IN PROPULSION.

The resistance a vehicle offers to motion may be divided into three principal elements, viz:

1. Kinetic resistance, or that which is common to all masses moved through any given medium.
2. Internal resistance, or that due to the construction of the vehicle itself.
3. Road resistance, or that external resistance due to the nature of the road the vehicle travels over.

The first can be calculated from known laws of kinetics; the second our experiments bear on; the third contains elements for further investigation than it has so far received. In this connection it was intended to have tests made of the resistance due to various road surfaces by measuring the energy input of the electric vehicles competing. The heavy fall of snow at the time of the Thanksgiving Day race interfered with these plans, and an accurate profile of the course showing all grades, nature of paving and roadbed, which had been prepared, was rendered useless for such determinations at that time. It is to be hoped that further experiments will be made along this line to supplement what limited information is now available, and that future promoters of motocycle races will improve such opportunities for adding needed information in this and other directions.

In the following brief analysis of energy expended in the propulsion of a vehicle against the three elements above noted, application of the principles involved to the case of an assumed vehicle may possibly be the best method of making the subject clear. Let us then assume a vehicle as follows:

Weight, 1,600 pounds, divided 1,200 on drivers and 400 on steering wheels.

Speed to be attained, ten miles per hour, or 880 feet per minute.

Surface exposed to air resistance, 20 square feet.

Elastic tires and ball bearing axles.

Motor, three horse power; efficiency, 50 per cent.

Taking up, then, the element of kinetic resistance, we divide it as follows:

(a) To give the desired method to the mass. To this end a force is required which will be found by dividing the energy of direct motion (found by multiplying the mass in pounds by the square of the velocity in feet per second and dividing by twice the rate of acceleration of gravity) by the distance in which it is desired to accelerate to the required velocity.

The energy of direct motion of the assumed vehicle moving at the rate of ten miles per hour is, therefore:

$$\frac{1600 \times 14{\cdot}66^2}{2 \times 32{\cdot}2} = 5340 \text{ foot pounds.}$$

If it be desired to accelerate to this velocity in a distance of 200 feet, then the applied force must be, for overcoming this element:

$$\frac{5340}{200} = 26{\cdot}7 \text{ pounds.}$$

Should it be necessary to stop the vehicle in a distance of fifty feet, the retarding forces acting upon it, to give this result, would equal a force of

$$\frac{5340}{50} = 106{\cdot}8 \text{ pounds.}$$

(b) To overcome the component of gravity in climbing a gradient. For this purpose a force is required which will be found by multiplying the weight of the vehicle by the sine of the inclination of the gradient (approximately the percentage of gradient). Thus our assumed vehicle would require $0{\cdot}05 \text{ of } 1600 = 80$ pounds force to overcome the component of gravity on a 5 per cent. inclination.

In descending such a gradient a pull of 80 pounds would be exerted by gravity, and if say only 32 pounds were required to keep the vehicle moving at a uniform speed, the brake would have to counteract the difference of 48 pounds, and thus energy would have to be dissipated at the rate of $48 \times 880 = 42{,}240$ foot pounds per minute.

Thus in descending a 2 per cent. gradient giving a gravity pull of $0{\cdot}02 \times 1600 = 32$ pounds, no energy is dissipated. In a gradient in excess of 2 per cent., part of the energy of position must be dissipated, by application of the brake, to prevent undue acceleration of the vehicle.

(c) To overcome the resistance of the air. For this purpose a force varying as the square of the velocity is required, and for moderate velocities this is found approximately per square foot of surface exposed by dividing the square of the velocity in miles per hour by 200. This, for the assumed vehicle, not considering wind, would be

$$\frac{100}{200} = 0{\cdot}5 \text{ pound per square foot.}$$

And for 20 square feet, the number we assume, we find $20 \times 0{\cdot}5 = 10$ pounds pull necessary to overcome air resistance. The work done in overcoming this is wholly dissipated.

(To be continued.)

THE promoters of the Heilmann locomotive appear to have the courage of their convictions, for they are now building two very powerful engines for handling heavy loads at high speed. They are intended to haul trains of 290 tons at 62 miles an hour. The horse power is 1,900 and the complicated arrangement of generators, etc., are mounted on two trucks of four wheels each. The motors are gearless, driving the axles through elastic couplings.

[Continued from SUPPLEMENT, No. 1058, page 16915.]

MECHANICAL ROAD CARRIAGES.

By W. WORBY BEAUMONT, M.Inst.C.E.

[Cantor Lectures before the Society of Arts.*]

LECTURE III.—Continued.

IT perhaps will afford some proof of the confidence which is placed in the working of these carriages if I mention that the director of public works at Colombo has just been authorized by the government of Ceylon to purchase a few Daimler motor carriages for the purpose of carrying the mails from the general post office to the railway stations at Colombo. The daily distance to be covered by these motor mail carriages is about twenty miles, but a very large saving, it is expected, will be made by their use as compared with the use of horses.

The motor omnibus is one of a very large number of different types made in Mannheim by the Benz Motor Company. I have chosen this one to give you an idea of the utilitarian application to which the petroleum or benzoline motor is applied as distinguished from the pleasure vehicles already referred to. From this it is sufficiently obvious that the motor and the mechanism behind it occupy very little space, and that it is in no way obtrusive or an inconvenience to passengers. The carriage is entered as easily as any other small railway omnibus, and it is a vehicle at which no horse could take the least fright. Chain gear is used to transmit motion to the road wheels from the two sets of pulleys, which are driven by means of belts, as will be seen from Fig. 42 of the De la Have carriage, in which the Benz motor is used.

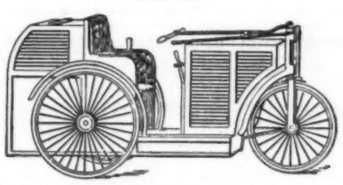
In the Roger carriage, already referred to, the arrangement of the gear is similar to that of the De la Haye carriage, shown by Fig. 42. A single cylinder Benz motor is used, driving a crankshaft which carries two pairs of pulleys, fast and loose, for driving a countershaft with corresponding pulleys for two different speeds.

At the center of the countershaft is a Holdsworth compensating gear and at its ends chain pinions for driving the road wheels. No arrangement is made for reversing the direction of motion, nor for these light carriages does it appear that this has been found necessary. In the larger carriages double cylinder motors are employed.

The steam carriage of M. Scotte, of Epernay, which entered the Paris-Bordeaux trials, was a rather heavy vehicle, which nevertheless ran very well until one of the Field tubes of its boiler burst and brought the run to a conclusion.† Its working, however, was so good it was awarded the consolation prize of £20.

The little two seat carriage, shown by Fig. 47, is one of the most recently constructed carriages now being made in two sizes by Messrs. Roots & Venables, of Westminster Bridge Road. It weighs about 8½ cwt.,

FIG. 47.



ROOTS AND VENABLES' OIL-MOTOR CARRIAGE.

is fitted with a two horse power Roots oil (not benzoline) engine, and the larger size, to carry four persons, is fitted with a four horse power oil engine and weighs two cwt. more. The frame is made of steel tubes which do duty as water circulating tubes, supplementary to a special water cooling device in the front of the vehicle.

Several firms in England are now turning their attention to the construction of oil engines for motor carriage purposes, and many are already preparing to construct carriages and vehicles of various forms using motors of other makers. I cannot, however, refer to these specifically, as some of them have not yet completed their designs. The Kane Pennington motor I can only refer to, as I am not yet informed as to the precise details or the system on which it works. It has recently been several times described in the engineering press, but the description is unsatisfactory as at present given.

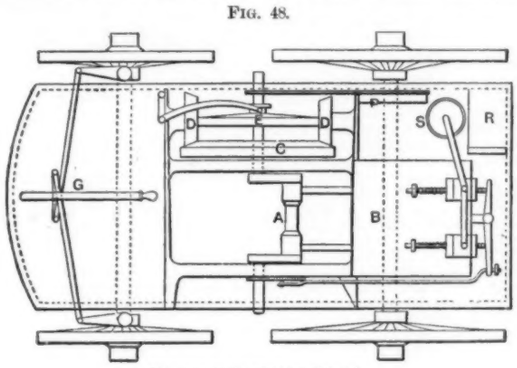
Fig. 48 shows in plan the arrangement of the benzoline motor carriage made by M. Teuting, and entered for the Paris-Bordeaux trials, but thrown out of the running by, it is said, an accident. It is a vehicle with seats for four, and has much the appearance of the Victoria. Like most of the French carriages, it was fitted with wood wheels, and it was driven by a double cylinder, single crank motor.‡ On this crankshaft, according to published accounts, there was a flywheel, G, with beveled periphery upon which two friction cones, D, ran and gave motion to a disk, E, and to a chain pinion at the back of it by which the driving axle was operated by a chain wheel, P. The arrangement thus described does not accord with the view which has been published elsewhere of the carriage taken from a photograph, but the gear is the subject of a French patent. The front wheels are carried on short axles according to one drawing, as shown, and according to another drawing they are carried on a through axle supporting ordinary locking gear. From what I have said and described, it will have been seen that the development of motors, after the subject was dropped by Hancock and others, took, with a few exceptions, the form of the heavier engine and heavy boilers, with, until very recent times, comparatively low pressure. With the exception of Perkins, the high pressures which would make light boilers possible have not been used, and the new direction of development of motor has almost entirely taken the form of the internal explosive combustion engine chiefly, or the Otto cycle.

All those engines of which we have heard so much in connection with the Paris trials were of this type, using benzoline, and although, as far as I know, no accident has occurred with any of the several hundreds of these vehicles now in use, an objection is felt in this country to the use of this light volatile oil.

It may be well worth considering whether the high pressure hot air engine, with internal combustion perfectly conducted, as it may be, as is now known, may not yet provide the means of construction of a suitable engine with no objectionable exhaust. Stirling's hot air engine* may, to some extent, form an indication of the lines on which some theoretical and practical considerations, with this object, might be based, internal combustion of oil by a burner under a pressure being used instead of the externally heated cylinders of Stirling's engine. So much is known now of the combustion of liquid hydrocarbons under different pressures and temperatures that, aided by some of the devices for ignition which have been used in oil and gas engines, it would seem that the time has arrived for devoting some attention to development in a direction which seems to have been neglected.

Now, the time has so quickly passed that I must leave other illustrations of what has been accomplished and refer for a few minutes to questions that will be of more interest, perhaps, to those who are considering the motor carriage of the future. The first thing that has to be considered is, Who will want, and what are the purposes to which, motor carriages are most likely to be applied? We have to consider this, because already people are talking of making carriages—or vehicles, I would rather say—that fulfill no particular requirements and which seem to have no particular recommendations, as considered from the point of view of any of those who want them for pleasure purposes, those who want them for business purposes or those who want them for heavier work. The next point we have to consider is, Who can use the carriages when they are made, that is to say, what sort of man or attendant will be necessary to keep in order or to work either of the forms of carriages that have to be made? Must we have a trained mechanic or must we have an intelligent engine driver, or will it be sufficient to have an ordinary, intelligent handy man, such as many gardeners, who can, and do at the present time, drive gas engines to run dynamos in many country houses? Or can the carriages be fitted with motors? and there is no doubt some of the benzoline motors are made so

FIG. 48.



TEUTING'S CARRIAGE (PLAN).

that they give very little trouble to men who, with a little mechanical sympathy, can attend to the vehicles themselves.

If we make vehicles like a good many of those that have been constructed since the time of Hancock, which require a driver and separately a stoker, we shall be making something that will be—except for omnibuses and the heavier work—inferior to those which are, or will be, made by our neighbors, more especially for the small vehicles. When we have to supply a vehicle for those who will use them for business purposes, vehicles of the heavier order, this objection does not obtain, or does not obtain to the same extent; but we have to remember that if business is to be done on any scale with these vehicles for general users, these users must be able to run them without difficulty. No skilled or very little skilled attention must be necessary, otherwise we shall no more get the English people to use them than we would get them to use tricycles or bicycles if mechanical skill were required.

Another point that I would mention is the question of speed. Most of those of the early days, whose carriages I have described, lost a great deal by attempting too much speed. For road carriages it is a question whether high speed is necessary at all. Very moderate speed will, in the opinion of most people whose opinion is, I think, worthy of consideration, be sufficient. It is useless to make vehicles provided with the capacity for very high speeds; vehicles which are capable of attaining those speeds will, after all, not be permitted to be used, first, because they will be dangerous, and secondly, because people will not buy vehicles which have powerful engines whose power is seldom, if ever, wanted. The vehicles which are required will, as a rule, have to run at slow speeds or at moderate speeds, and the means of running at high speeds can only be obtained with heavy motors and gear.

With regard to the changes of speed, that is to say, variable speeds for the different purposes of level roads and hills and starting, and so on, I think it may be seen by careful consideration of what has been done and what is wanted, that the motor which will give the moderately high speed of say 10 to, at the most, 12 miles an hour, and only provided with a simple low speed gear, such as will enable them to start easily or to get up a hill as horses do at a very moderate speed, but which will at the same time be the means of using an engine of very small power, will be that which will meet most requirements. In order to obtain a number of speeds, or a great variety of speed, we must have either complicated gear or we must have a great reserve of power. Great reserve of power means greater weight than is necessary for that which, in 90 cases out of 100, purchasers of these vehicles will require. I know that the speeds that have been obtained by several of the English engineers to whom I have referred are easily obtained, but you will find that it was only by means of very considerable weights, weights that were absolutely unnecessary for anything like the ordinary uses to which these vehicles will be put, and even then those speeds were only obtained by engines and boilers which formed about 75 per cent. of weight of the vehicle and the load they could carry. We see the oil motor carriages and the benzoline motor carriages have already run very far away from that sort of thing, and it remains for us to show that we can make vehicles which will enable us to arrive at the speeds that are useful and at the same time a vehicle which is light, simple and not too costly. The French and the German motor carriage makers have already done well, but there are not, I believe, more than a few whose carriages can, for English requirements, be looked upon as more than in the advanced experimental stage. We shall require carriages which weigh no more than theirs, but which are stronger in all the essential gearing and wearing parts, and which are much quieter and in no way a nuisance.

The next point, and I will only occupy a minute or two more, is the question which has no doubt been occupying the minds of a great many, viz., Is the motor to be steam or electricity or petroleum engines, or what form of motor is it to be for these carriages of the present and future? To one point on this subject I have already referred. There is, most persons think, a good deal of room for the steam motor, although the oil motor has been running away with most of the prizes of late. It will not do, however, to think that the steam motor carriage can be made whose duty is chiefly to carry an engine and boiler.

Most of the boilers that have been used by those who have worked in this direction hitherto, or at all events since the days of Hancock, Church and others, have been too heavy. It will be necessary to use boilers of the race horse type, probably boilers of the instantaneous generation type, boilers on the principle of that to which I have referred of M. Serpollet, boilers that make it unnecessary for the driver to be very much troubled as to where the water stands, or when called upon to stop in consequence of an accident on the road in front of him, or of a block in the traffic in the streets. He must be independent of that, otherwise the steam boiler is out of it for that sort of work. Even if boilers to carry any given quantity of water are used, then that which has already been shown to be possible, viz., self feeding, self regulating arrangements, must be used, but they must be of a simple order. Then, these things being secured, we have to admit that the steam engine has some advantages over other motors, inasmuch as it may be stopped and started at any instant, to give any power from a few foot pounds up to its full power, and is, in fact, what railway men call more flexible than any other form of motor, and it is not impossible that a steam engine in the form of a rotary engine, that is to say, a steam turbine, may be used, which would run practically without vibration. The only difficulty—perhaps the one difficulty in this sense—is the form of gear that shall reduce the very high speed of the steam turbine down to the speed of the road wheels. That overcome, we have to-day a steam motor which, for such powers as we require for these purposes, is as economical as the high speed reciprocating engine. The gear I have already mentioned, and I may say again that, if it is to be used at all in these things, it must be much more simple than any that has been used at present.

The last point to which I would refer is the fact that wood wheels have been preferred in the many carriages lately built and have been very successful, and there seems little doubt that India rubber tires, perfect as they now are, ought to enable the engineers and carriage builders to achieve success far more complete than that of our forefathers, great as it was, fifty years ago. We may use for many vehicles with perfect success, and with much greater cheapness than many people are aware, pneumatic tires of several forms. It is hardly necessary to mention the names of those who make them, but everybody knows the Dunlop and the Pneumatic Tire Company and the North British Rubber Company, who make them of forms now that overcome the difficulties I mentioned last week. I referred to Thompson's tires, which were soft India rubber throughout their whole thickness, and which, under any speed, left the wheels upon which they were running and preceded them in front by several inches, and in that way did work upon themselves which gradually meant deterioration. These tires are made now with the soft form of India rubber on the exterior and with the harder vulcanized India rubber within, so that the part that fits upon the wheels is hard and non-extensible, and has no tendency to break away from the rim of the driving wheels. The various points that I have been able to put before you have only lightly

* From the Journal of the Society of Arts.

† The Engineer, vol. lxviii, pp. 47, 86.

‡ La Locomotion Automobile, June, 1895.

* Bourne. "Steam, Air and Gas Engines."

been touched upon, though I hope I may have directed attention to those that are of some importance in what everybody hopes will be a great industry. We have seen how very rapidly the cycle manufacturers, by the aid of machinery which will reproduce cheaply very nicely constructed details, have shown all engineers how to use ball bearings with very great success, though we used to think little of them a few years ago; have shown us how to make light frames for light vehicles with perfect success, and they have shown us how an industry which employs hundreds of thousands of people may be created in a very few years. I think what they have done is an encouragement to us to persevere in the design of a conveyance which shall be all that the public will require, and not merely that which the engineers would like to design. It will encourage us to insist upon the removal of those legal restrictions which at the present time are alleged at all events to be the chief cause of our being as manufacturers second to those of France and Germany, instead of being first, as we should have been if we had properly followed up the work of the English pioneers of sixty years ago.

INCLINED PLANES FOR BOATS -- THEIR EARLY USE AND MORE RECENT EXAMPLES.

THE first use of locks in inland navigation is attributed to the Italian engineer Viconti, and their introduction into France is credited to Leonardo da Vinci at the beginning of the sixteenth century. The use of inclined planes for raising boats had also a quite early origin, and many examples of such constructions have been found in different countries, particularly among the Chinese. Fig. 1, as drawn by the pencil of Mr. Albert Tissandier, who made the sketch during his first voyage in Asia, represents one of these planes located at Ning Po. It consists of a flagstone pavement ten feet in width, laid between two walls. The slope is about thirty degrees. It is a question here only of junks of small tonnage, the ascent and descent of which are effected by means of two connected upright windlasses. For the ascent as well as the descent, the ropes are hooked to the stern, the weight of the boat and its load in the latter case acting as a motive power and the ropes forming a brake. The picture represents an ascent of the boat with the master fisherman standing at the stern in order to direct the maneuvers. These junks have no keel, and must, necessarily, be of very strong construction in order to permit them to resist the shocks that this unequal mode of traction causes than to undergo, as well as to resist the weight of their cargo, which is no longer counterbalanced by hydraulic pressure. In this warm and moist climate, however, the flagstones of the plane are always covered with quite a thick layer of mud, which considerably aids the operations.

Very different, and better perfected, as regards the details of construction and exploitation, is the system that was operated as long ago as the end of the sixteenth century upon the lagoons into which the Brenta empties at about five miles from Venice. We borrow a description and figure of this from a very curious work published at Padua in 1607, and entitled: Novo Teatro di Macchine et Edifici, di Vittorio Zonca.

Here, as the strip of seashore that separates the Adriatic from the lagoon had to be crossed in both directions, the inclined plane presented two slopes in opposite directions. The apparatus had two tracks, each of which was provided with a special horse whim, or windlass. These whims, which were very simple and strong as regards construction, were provided with a lantern wheel having twelve trundles and actuating a thirty-six toothed face wheel.

According to the Italian text, the whim to the right hauled the boats from the lagoon toward the river and the one to the left hauled them in the opposite direction. The boats rested upon a truck similar to the device now used for maneuvering casks, and which was provided with four wooden wheels a foot in diameter, hooped with iron and mounted upon axles of the same metal. At each extremity of the longitudinals there were strong rings, to which were hooked the traction cables. The truck rolled over a track, B, of hewn stone carefully dressed, that took the place of our present rails. The apparatus was, therefore, arranged according to most of the mechanical principles that we favor to-day, viz., actuation through a relatively powerful and sufficiently regular motor; placing of the boats upon a cradle in order to protect them against friction upon the inclined plane; and substitution of rolling for sliding friction, etc. The only thing in which the system fails, so to speak, is the saving in motive power obtained through the descent of one of the boats forming a counterpoise to the ascent of the other. But it will be observed that, in order to realize this in a continuous manner, it would have been necessary to await the coincidence of two operations in contrary directions, a thing that could not frequently occur, or the establishment of a double track with a truck forming a counterpoise, and with brakes—means somewhat complicated for the epoch. As for the use of the horse whim, that was necessitated by the impossibility of borrowing the motive power from water, inasmuch as the lagoon and the sea that it was a question of connecting must have had about the same level. Otherwise it is probable that recourse would have been had to undershot wheels, since numerous applications of these exist in Zonca's work. The author is, moreover, perfectly familiar with the theory of the lever and of gearings. He points out, in addition, that the summit of the inclined plane was at a height above the level of the water such that it was submerged during rising water, so that navigation had no need to borrow any special motive power in order to cross the belt of seashore, and he explains, too, that the rows of stone that serve as a track for the wheels of the truck terminate in strong courses, in order to assure the solidity of the work. It will be seen that the installation was established under excellent conditions that do real honor to the Italian engineers of the sixteenth century. At the same time, this curious description demonstrates that inclined planes for boats were contemporaneous with canal locks. Although, up to our day, they have not been the object of applications as numerous as those of the latter, they present advantages as regards simplicity of maneuver, solidity, and facility of maintenance that permit of the operating of them being intrusted to employes of an inferior order, and of the interruptions of service upon canals and navigable rivers being reduced to a minimum.

In connection with the foregoing article, from La Nature, we give a figure and description of an inclined plane for boats devised by Nicolas Grollier, an inventor of the seventeenth century, whose original inventions and improvements upon and modifications of existing machines were illustrated and described in a book published by his grandson in 1719. The chapter in which this arrangement is explained is headed: "Machine for carrying a large boat from one canal to another and higher one without being obliged to unload it, and without the aid of a lock."

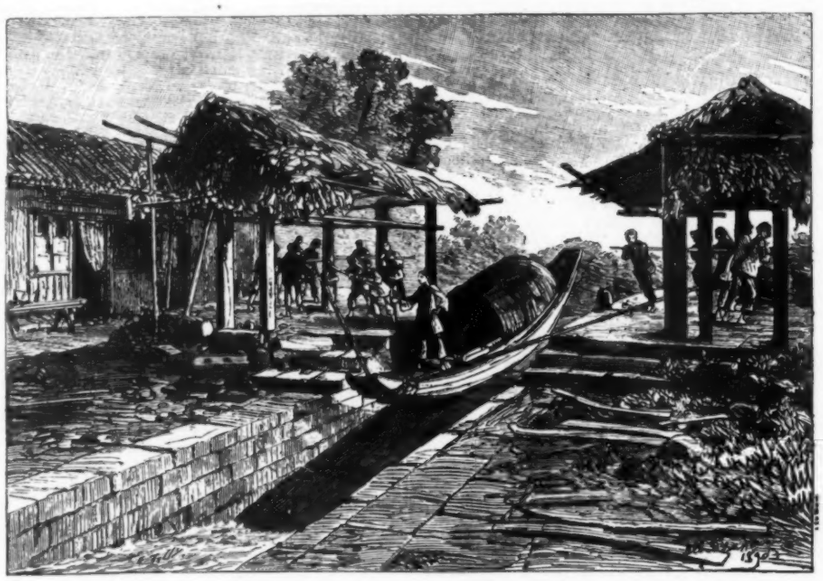


FIG. 1.--INCLINED PLANE FOR BOATS AT NING PO, CHINA.

"The large boat, A, having reached the end of the canal, B, it is a question of raising it to the canal, C, and, to effect this, the glacis, D, and the platform, E, on the two sides of the canal have been contrived.

"In each of these platforms there is a species of capstan, composed of the shaft, F, of the lantern wheel, G, of the large face wheel, H, and of the axle of this wheel. The ropes of these two capstans being wound around the axles of the wheels, H, after passing over the pulleys, I I, are joined by the two pulleys, K K, and end at the hook, L, which is firmly attached to the large rolling truck, M.

"This large truck, M, being made as the figure represents and of precisely the size of the boat, one lets it down into the canal, B, in order to place it beneath the boat. Afterward, having attached to the hook, L, the two ropes of which we have spoken, it only remains to cause the capstans to act, and this is done as follows:

"By means of bars passed crosswise into the shaft, F, four men, or more, if it is necessary, cause it to revolve, and, at the same time, cause the revolution of the lantern wheel, G, the face wheel, H, and its axle. Thereby, the ropes hooked to the large truck that supports the boat, being wound around the axle of the wheels, H, draw the boat out of the canal, A, and cause it to insensibly ascend the glacis, D, up to [a point] a little above the level of the water of the canal, C, whence, through its own weight, it descends another and smaller glacis into the canal, C, where it readily abandons the large truck, M. It will be easily understood that with this machine it is not necessary to unload the boat, A, in order to cause it to ascend from one canal to the other; and this is very convenient and greatly abridges the time of navigation."

THE INCLINED PLANE ON THE MORRIS CANAL.

From an elaborate paper written by Herbert M. Wilson, C.E., of the Columbia College School of Mines, we append the following particulars relative to the modern use of the inclined plane on an extensive scale in canal navigation, the illustrations giving a good idea of the operation of the system at the present day. The canal extends from the Delaware to the Hudson, and is one hundred and two miles long. The elevations are:

Mean tide water to canal summit.		
12 inclined planes	757 feet.	
16 lift locks	157 "	914 feet.
Delaware River (low water) to canal summit.		
11 inclined planes	691 feet.	
7 lift locks	69 "	760 feet.
Total rise and fall		1,674 "

SUMMARY OF COST IN ROUND NUMBERS.

From Delaware River to Newark	$2,000,000
Alterations of planes in 1835-36	230,000
Extension to Jersey City in 1836	600,000
Greenwood reservoir and feeder	170,000
Enlarging planes and locks in 1841	400,000
Total	$3,400,000
Enlarging canals and rebuilding planes	1,700,000
Total cost	$5,100,000

The greatest rise in any plane is 100 ft., its length

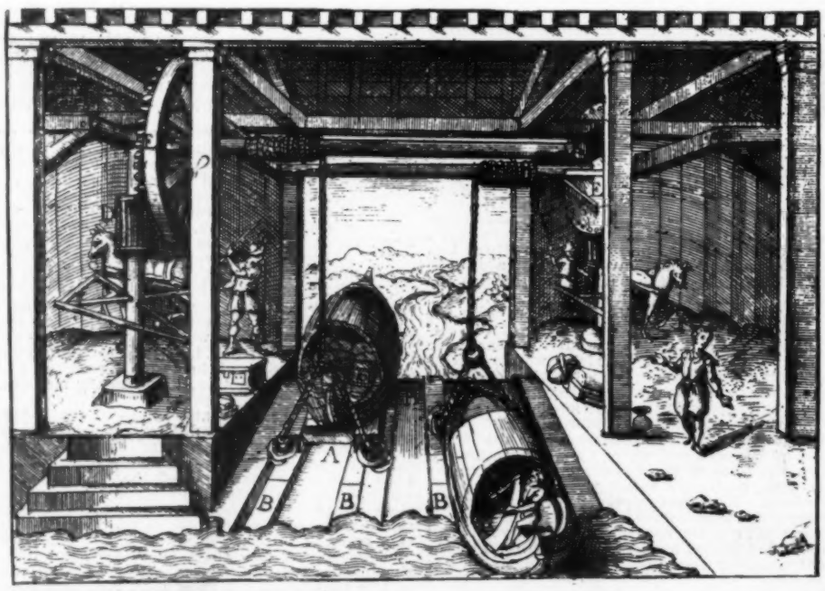


FIG. 2.—A SIXTEENTH CENTURY INCLINED PLANE FOR BOATS UPON THE LAGOONS OF THE BRENTA, NEAR VENICE.

being 1,600 ft. (near Washington, N. J.) The summit is at Port Morris, 41·34 miles from the Delaware River, and 60·80 miles from the Hudson River. The least rise of any plane is 44 ft. It is 3·4 miles from the Delaware and 99·11 miles from the Hudson River. The whole length of the canal is 102·15 miles, the longest level (at Paterson) being 17·5 miles.

The boats, which are in two sections, are joined together by latches and steadying pins, the ends abutting against each other. Transverse partitions of wood separate the two compartments, each of which is really a boat by itself. The average tonnage is about 65 tons, but the planes can transfer boats of as much as 100 tons weight. The sectional system of boats was not adopted to suit the planes, but was previously introduced. It is, however, of great advantage in the use of the planes. The first of the class of planes at present in use was introduced in 1848, at a cost, including machinery, of $27,835. It is 900 ft. long and the fall 51 ft. It superseded six locks. The track of the plane in each case runs a short distance along the bottom of the lower bay, under water, rises up the incline to above the water level of the upper reach, then descends into the upper reach and runs a few feet along the bottom. The grade of the inclines is, in general, about 1 to 11. The trucks which carry the boats are, like the boats, divided into two sections, each section having eight wheels with flanges on each side of the rails. They are provided with strong stanchions, to which the boats are fastened with hawsers. The planes are in each case worked by a reaction water wheel, and the levers for regulating the supply of water and for the control of the brakes are in a high tower, from which the man in charge can see the whole plane. This tower contains also the water wheels and other machinery, and is about midway between top and bottom of the plane and at the end of the flume. The water wheels have four arms and describe a circle 12 ft. in diameter. The openings for efflux of water at the ends of the arms are 15½ in. high by 3⅛ in. wide, and the wheel is placed far enough down the incline to get a head of 45 ft. The discharge is 1,000 cubic ft. per minute, and 235 horse power produced. The quantity of water needed for these wheels is less than one-twentieth of the amount expended in a series of locks of the same total height or lift.

The first boat tried on the plane, which was opened in 1848, was taken up in 3½ minutes, the weight of boat and cargo being 70 tons. These inclines were constructed under the direction of Messrs. Asa Whitney and W. H. Talcot, chairman and engineer of the company. The wire rope and the trucks used on these planes were manufactured by J. A. Roebling & Sons, of Trenton. The winding drum is 12 ft. in diameter, and is worked by the water wheel; it has a continuous spiral groove of 3 in. pitch in its periphery. The rope is fastened at opposite sides of the drum, so that, as one end winds, the other unwinds. The motion is rendered reversible by a clutch on the jack shaft of the water wheel. The Stanhope plane is of the same general type as all the planes west of the summit, and may be taken as an example. The plane has a single track of two lines of heavy steel rails, 12 ft. 4½ in. from center to center. The rails are 3½ in. broad at top, 3½ in. high, and weigh 76 pounds to the yard. They are spiked to longitudinal stringers of wood 6 in. high by 8 in. wide, resting at intervals on large flat stones two-thirds embedded in the ground. The car or cradle is in two sections, fastened together by a chain and a link. Each section is provided with snubbing posts, by which the boat is secured in the proper position as it floats into the car. Long "fender" boards on each side serve to support the boat when it is hauled from the water. The wire cables are so arranged that as one winds on the drum the other unwinds. The two ropes pass around submerged horizontal sheaves at the bottom and top of the plane. The car has a wire rope attached at both ends, the "back rope" to one section and the main rope to the other. The latter is fastened to a small drum on the car, by which the slack can be taken up and the rope kept taut. Each section of the car has eight double-flanged wheels provided with brakes.

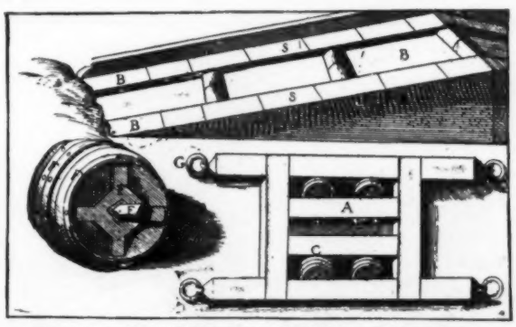


FIG. 3.—EXPLANATORY DETAILS OF BRENTA INCLINED PLANE.

A. Truck with its wheels, C. B. Inclined plane. C. Wheel with its iron hoops and its axle. F. B B. Large flagstones. S S. Rows of dressed stones forming a track. G. Iron rings to which the traction cables are attached. D. Lantern wheel. E. Face wheel.

If the car is to be drawn out of the lower reach and up the plane into the upper bay, all that is necessary is for the engineer in the plane house called the "plane man," to turn the "tub wheel," which lets the water into the reaction water wheel, and the drum winds up the cable at one end and unwinds it at the other, drawing the car up.

To take a boat down the plane, if it is empty, it is hauled out of the upper reach, the water shut off the wheel, and the car allowed to descend by its own weight. A boy on the car can apply the brake if the speed of descent becomes too great. If the boat is loaded, the plane man puts on about half water—that is, opens the tub sufficiently to allow one-half the amount of water for full power of wheel. This prevents the boat from going down too fast. The planes west of the summit are uniform; those east of it vary somewhat. At Drakesville, for instance, the plane is 1,770 ft. long from center of wheel pit to center of wheel pit; its total rise is 50 ft.—grade 1 in 10; it requires 3,900 ft. of cable to work it, and the total head on the wheel is 30 ft. It differs mainly from the Stanhope plane in having but two lines of cable instead of four, and but two grooved pulleys. This simplifies the construction materially and makes a great saving in wire cable, pulleys, pulley block stands, etc. Besides, the plane works more easily and there is less slack. Instead of passing out in the same direction from opposite ends of the perpendicular diameter of the drum, it passes out in opposite directions from the same end of the diameter. Instead of being carried all the way on small pulleys, the cable is supported near the water's edge on two large vertical 11 or 14 foot groove wheels. These wheels are in large masonry pits or slots in the ground, so that their upper surface is but a little above the surface of the ground.

All of the east side plane houses are two stories high above the ground, instead of three stories, as on the west side, the brake and reversing lever attachments being thereby greatly simplified. All the water wheels are covered with a plate of iron above and below; this entirely covers them, excepting a few inches over the nozzle. In all other respects these planes are entirely similar to the one at Stanhope.

At Washington and at Newark there are planes of a different construction. These are doubled tracked, two double lines of rails running parallel and the whole length of the plane. There are two cars, one ascending while the other descends, meeting half way. The cable is arranged as at Stanhope. This arrangement relieves the machinery of part of its work, as the descending car helps in raising the other one.

To take a loaded boat up the plane at Stanhope, from the time it starts below until it just floats in the upper bay, it takes from 5 minutes 10 seconds to 6 minutes, the average being about 5 minutes 30 seconds. For lowering a loaded boat, on the average, about 2 minutes 40 seconds are required; for an empty boat, 2 minutes 50 seconds. For an empty car, without boat, 2 minutes 45 seconds. As it would take about four such planes in length to make a mile, it would require 11 minutes to draw an empty boat a mile up such a plane. For a descending loaded boat, 9 minutes; for an ascending loaded boat, 22 minutes are employed. These figures are approximately reckoned, and equal the ordinary rate of travel of the boats when drawn by

FIG. 4.—INCLINED PLANE OF THE SEVENTEENTH CENTURY.

mules, about one mile in 30 minutes loaded and one mile in 20 minutes unloaded. Hence we see that, unlike the locks, the boats are being raised and at the same time proceed at their ordinary rate of travel; for although while on the plane the speed is somewhat greater than in the canal, allowance must be made for the few minutes spent in getting the boats into the car; besides, in going a mile, the boat rises vertically about 300 feet on this particular plane.

From the above we find that while a boat takes probably about 8 minutes to go through a lock of 6 feet rise, to go through a flight of 12 locks, equal to a plane with a rise of 70 feet, would take 96 minutes; and during all this time a boat not only, in passing a plane, loses nothing in horizontal motion, but by the saving of time is enabled to advance about 5 miles while the other boat is passing the locks. The saving of time is evidently considerable.

On the whole canal there are twenty-three planes, with an average lift and length of that at Stanhope—the total length six miles. It takes the empty boats 66 minutes and loaded boats 198 minutes to travel this distance, and as there are as many boats going down as there are going up, the average time consumed in traveling these six miles is 133 minutes, or one mile in 22 minutes, which is better than ordinary canal speed. If, instead of these planes, there were twenty-three flights of locks, each one consuming 96 minutes in its passage, the whole would require a loss of 36 hours, or in distance—at the rate of one mile in 22 minutes—of about 100 miles!

The cargoes carried on this canal are almost exclusively coal and ore, with occasionally a load of grain or wood. Of wood, grain, or coal, the boats take a full load to sink to the water line, but ore being heavier for the same bulk, a very little in the bottom is all they can carry. The usual load is 70 tons, but sometimes 75 and 80 tons are carried; the latter, however, is uncommon. The empty boats weigh from 14 to 18 tons, average 17 tons. The cars alone weigh from 38 to 45 tons, and average 40 tons; hence, the average weight raised on the planes is 127 tons, and it may be as high as 143 tons. The grades are never very steep; at Stanhope the grade is about 1 in 10; at Port Morris it is 1 in 20; the steepest, 1 in 9; average grade, 1 in 11.

Expenses.—The first cost of a plane considerably exceeds that of a single lock, as do also the running expense, repairs, etc. A plane with a rise of 70 feet, however, will cost very nearly the same as a flight of six locks of a rise of 12 feet each.

The wire cable costs about $1 per foot, and needs replacing about once in three years. The large drum costs about $3,000, and lasts many years. The entire machinery needs replacing about once in ten years, with the exception of the drum and shafts, which last much longer. In locks there is very little repairing to be done, with the exception of the wickets, which do not last, but are small and cheap.

We will compare an average plane, as that at Stanhope, with a lift of 72 feet, with a flight of twelve locks lifting each 6 feet. For a loaded boat, the plane takes 5 minutes 30 seconds = 330 seconds for passage. The water in the flume lowers 7 inches and flows at a velocity of 120 feet in 60 seconds = 2 feet in 1 second. The flume is 8 feet wide; hence the wheel consumes $8' \times 2' = 16$ square feet of water per second; this multiplied by 7" in depth, gives the consumption of $9\frac{1}{3}$ cubic feet per second; and if the boat takes 330 seconds for its passage, the total amount of water required to raise a loaded boat from the lower to the upper bay is $330 \times 9\frac{1}{3}$ cubic feet = 3,180 cubic feet. To take a boat down, the water lowers 1 inch; the velocity is 48 feet in 60 seconds, equal to about $\frac{3}{4}$ foot in 1 second; this multiplied by 8 feet, the width of the flume, gives 6 square feet per second $\times$ 1" (the depth) = $\frac{1}{2}$ cubic foot per second; and for three minutes = 180 seconds it takes 90 cubic feet of water, which is expended in holding the boat back.

In a flight of locks each 95 feet long by 11 wide, with 6 feet rise, we have 95×11 feet $\times$ 6 feet = 6,270 cubic feet for only one lock; for twelve such locks, equal to a rise of 72 feet, the amount of water would be = 72,240 cubic feet. Hence, the locks expend about 23 times more water than the planes for a loaded boat, and 836 times more for an empty one. This item of economy of water is of prime importance in canals, especially in dry seasons.

The question whether the locks or inclines can be most advantageously used on a canal for effecting a change of level is not readily answerable. The advisability of adopting one system or the other depends, in each case, on the supply of water obtainable, and on the amount of traffic. The expense is reduced by transferring a greater amount of load at one time; this requires a large expenditure in construction, and the advisability of making such expenditure depends on the amount of traffic. The planes, however, cost very little more than a flight of locks of the same lift, consume less

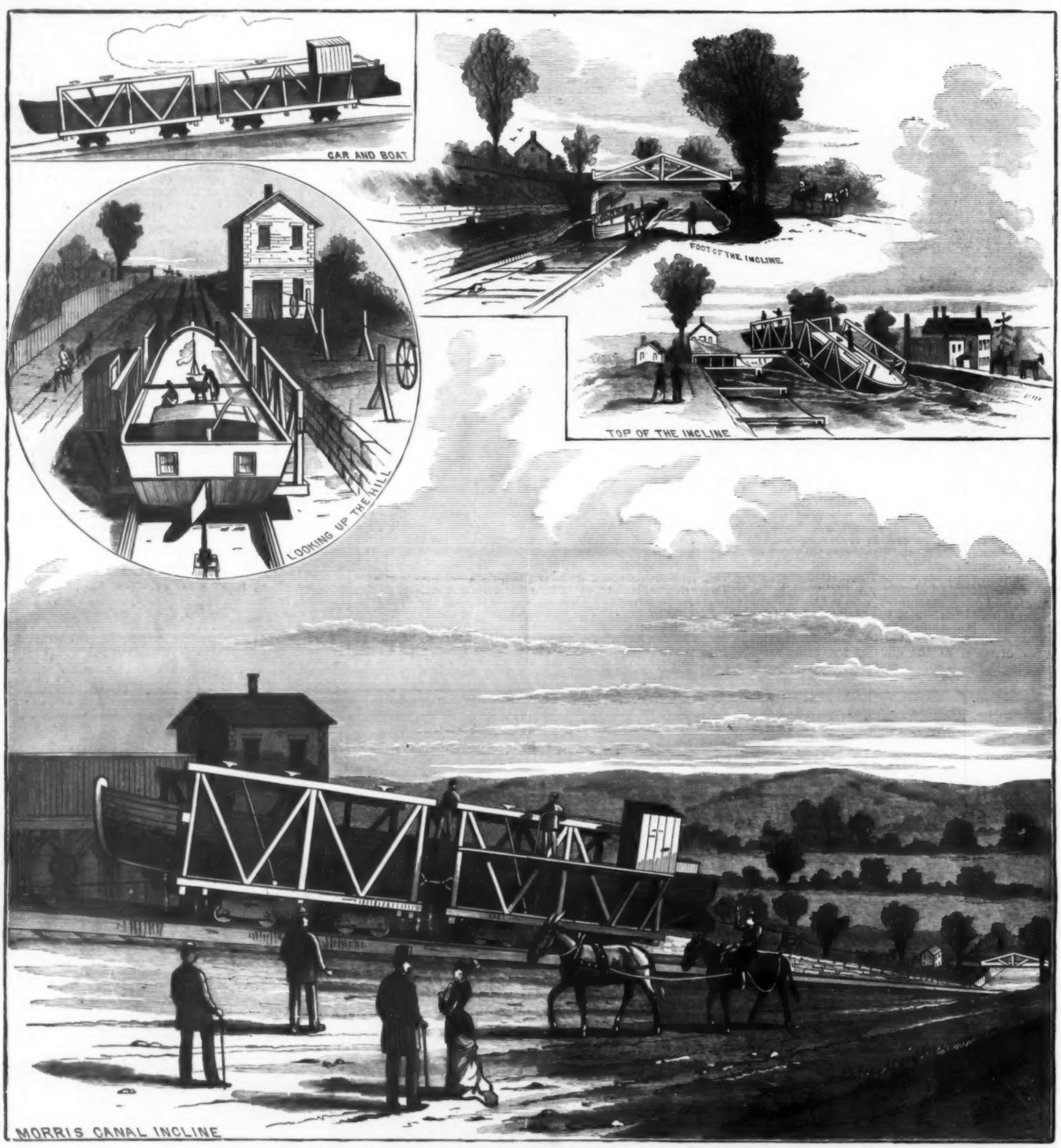


FIG. 5.—THE INCLINED PLANE OF THE MORRIS CANAL AT BLOOMFIELD, N. J.

than one-twentieth of the amount of water required by locks, and save 60 per cent. in the time of passage, as the average rate of travel (four to five miles an hour) is continued horizontally while the car ascends the slope.

To sum up, one lock is more economical than a short plane; a plane is more economical than a flight or series of locks, especially in the items of water and time. A plane involves more machinery, details, etc., than a lock, but not so much as to make it more expensive than five or six locks in series.

A PANORAMIC CAMERA.

To make a complete panoramic view with an ordinary photographic apparatus, it is necessary to expose at least eight successive plates if the objective, like those

FIG. 1.—THE CAMERA AND TRIPOD AS PACKED FOR CARRYING.

which are commonly employed, includes a 50 deg. angle. When the magnitude of the angle is less than 50 deg., the number of images required to represent the whole horizon is naturally greater. It increases also in a rather startling proportion, for the prints cannot be used in their totality. It is, in fact, almost absolutely necessary to make a double exposure for objects which are on the edges of two consecutive plates, in order to facilitate the joining and to guard against possible accidents which may take place during the course of the operations. Finally, to simplify these operations, one must generally mount on the camera a large annular objective which includes an angle of from 70 deg. to 100 deg., and sometimes even a little more. The number of plates is then reduced, but the difficulties are scarcely bettered. Col. Moessard constructed, some years ago, a special apparatus which permitted him to obtain in a single

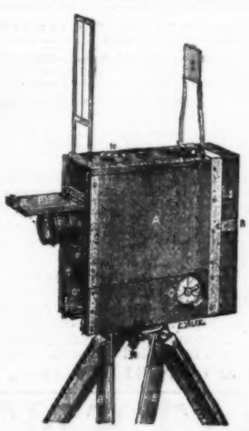


FIG. 2.—PANORAMIC CAMERA, WITH FIXED FOCUS IN POSITION.

exposure the image of all objects included in an angle of 170 deg., and to make a complete panorama either in three views of equal range or in three views of unequal range composed of two, including 170 deg. angles and a third which utilized only a part of the plate necessary to complete the 360 deg. This apparatus, which gives, by the way, some remarkable prints, comprises a fixed camera and an objective which moves around a vertical axis of rotation.

M. Damoizeau has undertaken to do away with this juxtaposition of images, and with his cyclograph he obtained, without a break in continuity, the negative, and, consequently, the photographic positive, of a complete circle of the horizon.

The cyclograph or panoramic camera, the invention of which already dates back some years, has been recently perfected. Two models have been constructed by the inventor. The first, provided with a variable focus, is especially convenient for the use of engineers, geographers, surveyors or explorers, since it is admirably adapted to all the operations of taking plans, chart making, etc., by the aid of photography.

The second model, with a fixed focus, is made in a very compact form and is the apparatus par excellence for the amateur. With few incumbrances, easy to place in position, taking up but little space, giving at will a continuous impression on the whole length of the film or a succession of isolated images, it presents no difficulty in handling. Added to these advantages is that of being able to inclose in the lateral magazines a supply of film sufficient to make thirty panoramas 0·80 cm. long and 0·09 wide, or 300 views 8 × 9 cm.

The traveler's panoramic camera, with a fixed focus like that in which the focus can be varied, is based on the synchronism which exists between the path traversed by the point of emergence of the rays passing through the objective and that traversed by the sensitive film, which unrolls in the camera without a break in its continuity.

Not only is the space the camera occupies greatly reduced, but it is also adapted, by making a complete

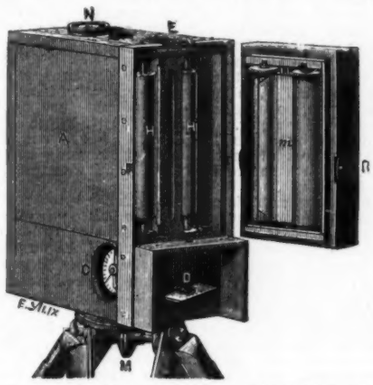


FIG. 3.—BACK OF CAMERA, SHOWING FILM CASE OPEN AND THE FILM ROLLERS.

revolution, to photograph at a single exposure the whole horizon.

Generally the amateur seldom wishes to make an entire panorama; so the inventor has provided means for limiting the quantity of sensitive surface to the exact dimension of the view to be photographed. The apparatus can therefore take the place of an ordinary camera, and give a greater or less quantity of isolated photographs, the width of which will vary with the varying proportions, while the length, according to the nature of the subject, will be between a certain number of centimeters for a corresponding number of degrees, and 0·80 cm. for the complete horizon.

The apparatus is composed of a box carrying in the front an objective mounted so as to slide out of its central position and, in the back, a frame with film carriers. In a double bottom is placed the clockwork which turns the camera at the same time that it works the two film rollers, H, H^1 (Fig. 3). By this method the rate of unrolling of the film is linked to that of the revolution of the cylinders and camera. The speed of

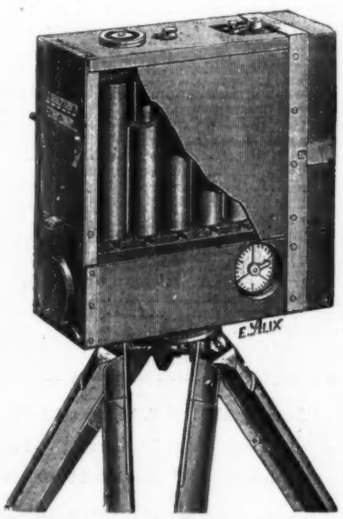


FIG. 4.—ROLLS OF FILM IN ONE OF THE LATERAL MAGAZINES OF THE CAMERA.

this last named and, consequently, the displacement of different parts of the system, can be increased or lessened by the interposition of a metal or paper fan (D). The indicator (C) shows at any moment the quantity of film used and that remaining available. The axis of revolution of the camera is strongly secured to the top of the tripod, in such a way as to permit the camera to revolve upon it freely without displacing the tripod.

The winding up of the clockwork is effected by the hand in a very simple manner. All that is necessary is to turn the box fastened on the tripod a certain number of times from left to right. The rewinding is finished when a clicking noise is no longer heard, but the box can, without harm, be turned still further; for in this condition it turns easily in one direction or the other, and aids the photographer in the determination of the point of exposure of the view. The roller box, the front part of which forms an integral part of the box proper, is composed of a movable frame in which are set the film rollers—the feeder (No. 1, Fig. 3) and receiver (No. 2, Fig. 3). The latter receives the film after it has received the impression of the light in passing before the opening, which is worked from the outside by means of a thumbscrew.

This screw, E (Fig. 3), placed on the top of the box, regulates the setting in motion or stopping of the apparatus. The space between the objective and the filmholder being useless for the working of the camera, has been fitted in the form of a reserve magazine for the films. This space is occupied by two rows of five rollers (b, Fig. 4), having in the middle an empty space of about a centimeter in width, which affords a passage for the light rays. Two doors, A, placed on the sides of the box, give access to the magazine. On top of the camera is placed a level, N, and at its side is a button showing the center of rotation. At both ends are fastened finders, which indicate the position of the image on the focal plane. The whole part of the subject included by the forward finder (the operator looking through the back one) will be reproduced upon the sensive surface in its natural grandeur. It is, therefore, easy to determine exactly the image. The objective is sharp to infinity, that is to say, it cuts clear at from ten to twelve meters, but its depth of focus permits of diminishing, if need be, this distance. The tripod is very rigid; its legs each divide into two parts at the top, and are fastened to the top piece by a screw bolt controlled by a central screw (see diagrams). The top has a collar turning with great friction and provided with a catch, which will stop instantly all movement of the box. By the position occupied by this button, the arrest is automatic at any point whatever, which can be determined in advance, or, indeed, the box can make a complete turn. The time of exposure depends:

1st. On the opening of the diaphragm of the objective.

2d. On the dimensions of the fan, D; the smaller this fan, the greater the speed of rotation, and, consequently, the shorter the exposure.

Notwithstanding the length of the rolls of film, the development is carried on as usual in an ordinary tray. For the views of the entire horizon, which have a length of 0·80 cm., use the same tray; holding the film in both hands, plunge it into the developer, and make the whole strip pass successively and alternately through the bath.

The panoramic camera has, over all the other ordinary apparatus, an advantage which, up to this time, has scarcely been made conspicuous; it is that of giving a perspective perfectly exact and, consequently, of making a faithful copy of nature, such as the eye perceives.

Space will not permit us to speak of the application of photography to the making of plans.—La Vie Scientifique.

ELECTRIC HEATING.*

By W. S. HADAWAY, Jr., New York.

WE have before us for the future two methods for the distribution of heat; the first a multi-potential heat system in which steam and electricity are the means of transmission, and second, a constant potential heat system in which electricity is employed as agent for diffused heat work in large volume, and the heat of resistance, either directly or with the additional heat of combustion with carbon, is used for high temperature purposes. The first is a combination of well-known engineering practices and represents elements in successful use at the present time. The second method appears more difficult, as it includes new methods of application and untried apparatus. For the present we have to approximate the probable final conditions by using materials at hand, so far as they will go, with reasonable economy, using every energy to broaden the general conception of the help and convenience arising from central station heat supply.

PRACTICAL APPLICATIONS OF ELECTRIC HEATING.

I. Car Heating.—The electric car heater has a small coal stove as its chief competitor. The car stove is usually placed midway in the car, the seat on one side having been cut away to let it fit in snugly, taking thereby the seats of two passengers. This system of heating is manifestly a poor one considered on the basis of heat distribution, and it also aggravates the faulty ventilation of a street car by gases from the coal burned.

In house or space heating on a considerable scale the generator can be located at a convenient point and the heat energy distributed efficiently by hot water and steam. In electric street cars the space to be heated is so small as to practically preclude the economical use of this method of heating. Hot water storage systems have been suggested and tried; but the objections of charging, attendance, etc., are evident.

The electric railway company usually own their own generating plant, which has been erected specially for the purpose, with good boilers, efficient engines, and large unit generators. The cost of power is a minimum, and there are cases in which it is figured to cost not over $2 per horse power per month. It is in a measure the ability to generate the power cheaply that makes it profitable to operate street railways by electricity. This same reason makes a certain amount of energy available for effective car warming at reasonable cost. The amount of energy available is dependent upon local conditions peculiar to each road.

Most of the car heaters now used are air heaters; that is, the resistance is so arranged as to permit the air to impinge directly against it and carry away the heat by convection currents. The heat ascends to the monitor and is rapidly diffused, with the cold air sifting in through openings in ventilators and window frames.

It may well be questioned in the light of modern heating practice whether this form of heater is best adapted for the peculiar conditions in car heating work, which really should not be heating at all, but

* From a paper read at the second annual meeting of the American Society of Heating and Ventilating Engineers, held in New York, January 21-23, 1896, and published in Iron Age.

effective warming. In common house heating, where electric heaters are used to give results immediately, they are connected in circuit; this is a better way to make the heater than a radiating surface. But in car work, where the heater is practically continuously in circuit, the radiator forms a better means of keeping a large percentage of the heat delivered at or near the floor of the car and about the bodies of the passengers.

The car heating tests made show that with the use of about four horse power the interior of the car can be kept practically at 50° F. From one point of view this is too low a temperature for comfortable passage. And yet if the heater is devised to deliver a part of its energy to the floor of the car, to keep it warm and dry, and about the limbs of the passengers, this is high enough for practical purposes. The problem of car heating practically resolves itself into providing a form of foot warmer heated by electricity and used for effective warming, rather than for heating per se.

On the Esquimaux plan of huddling together for warmth, a car can be kept at about 40° F. by animal heat; each adult passenger gives off 190 heat units per hour, or 14 passengers will give off as much heat as one electrical horse power hour. There are cases in practice in which the animal heat on some runs is practically the equivalent of the electrical energy used in heating. Clearly, then, the proper use of electrical energy is on the basis of individual effectiveness rather than for heating as commonly understood.

Using the methods commonly employed for computing the heat necessary for warming a 20 foot car requires eight horse power hours to keep it at 65° with the outside air at zero. In the cars examined in use the energy supplied for heating by electricity was about equal to the loss from glass radiation. There are cases in which the energy used for heating by electricity is 40 per cent. of the energy used in operating a particular car. And yet, assuming that five horse power is a fair average for use, the cost is about $10 per month per car for heating, or about 33 cents per day, or 2 cents per hour. The use of five horse power is a high one for effective warming, as it would heat 37 square feet of radiating surface to 185° with the car at 50°, while with the best systems of radiation for complete diffusion yet suggested the surface available is about 30 square feet, requiring four horse power to heat.

While most of the electric car heaters now supplied do not meet the conditions here imposed, the fact that several thousand cars are equipped with and are using the heaters attests their value. I beg to quote in this connection from a letter written me by a well known street railway expert:

"I think that the decision for or against heating in any particular case will have to be given with the distinct understanding that collateral advantages and not coal economy form the real criterion. You will remember that I spoke to you about a large plant which had been using heaters this winter with a very great expenditure of power. I had a talk with the manager a few days ago, with the following results: He admitted it immediately that it is costing him considerably more, in fact, about four times as much, to heat his cars by electric heaters as it did by coal stoves. He says, however, that he saves two seats in the car, that the people like the system of heating, and the cars are more attractive for this reason, and that on the whole he believes in it and would not go back to the old system, nor would he fail to adopt electric heating if the decision were to be made again."

This expression of opinion has been selected, notwithstanding the unfavorable comparative cost statement, to illustrate how far we have to be governed by collateral advantages in deciding for or against any particular application of electricity for heating purposes.

More large contracts for electric car heaters have been closed the past season than ever before, and there is every evidence that the electric car heater has become a staple commercial device. It would seem, in view of the facts, that the statements contained in volume 1 of the transactions of this society regarding electric car heaters should not stand without correction. The Metropolitan West Side Elevated Railroad, of Chicago, are now heating by electricity 155 cars, each 38 ft. 8½ in. long, 7 ft. 10 in. wide; center height, 8 ft. 6⅞ in.; side height, 6 ft. 7¾ in. Glass surface is 208 sq. ft. There are 12 heaters to each car, using maximum of 7,000 watts. The energy used is divided into two parts of 2,600 watts each and one part of 1,800 watts. The practicability of the equipment is shown by a recent order for 25 more equipments.

II. Air Heaters.—Outside of car heating these heaters have been used to a wide extent. One of the largest installations is in the office building of the Cataract Construction Company, at Niagara Falls, where all the heat is derived from this source. In cabins of steamships and yachts, bathrooms of houses, offices, libraries, etc., they are found useful devices. The writer pointed out in Heating and Ventilation for December, 1895, the relation which these heaters bear to steam heating systems.

In England and France some installations have been made on a considerable scale, and the work is of course simpler than the problem confronting us in this latitude, where the maximum capacity requires to be nearly twice the average. In heating the Vaudeville Theater, in London, the engineers write that they had to compete against a low pressure hot water system. There was difficulty in finding a suitable place for the furnace on that system, and in using electricity this difficulty was overcome. It is found in ordinarily cold weather that only two or three hours' heating are required, but with hot water systems it is impossible to limit the time in this manner, as the water takes two or three hours to heat up and the same time to cool down. The charge for current is 4d. per unit (about 6 cents per horse power hour). The lessees of the theater have expressed themselves perfectly satisfied with the results.

In this work the fact that heat is used only intermittently produces economical results, with even very high current rates. Take the case of a bathroom: Capacity of heater, 1 horse power; duration of use per day, 30 minutes; rate for power, 10 cents per horse power hour; cost per day, 3½ cents, or practically $1 per month.

III. Electric Cooking.—The results obtained in this line have been in a number of detached installations. Enough has been accomplished to show that electric cooking apparatus is practicable to use, economical in running cost, and extremely simple to operate.

Theoretically, of course, the oven is the device of highest efficiency and it is also found in practice a device of the greatest practical value. In Science for September 15, 1893, will be found the most comprehensive data regarding the comparative cost of operating the electric oven and the common coal range yet published. It is shown that the cost at average rates for electricity is practically the same for the coal range and electricity, provided an auxiliary water heater is used with the electric oven. It is not always possible in practice to confine the electrically heated apparatus to types as economical as the oven; but in a plant operated for several months and in which ordinary types of cooking utensils were used, the cost was found to be 2·5 cents per person per meal. Separating the energy used in this latter case for cooking from that employed for water heating, and the cost would be reduced by about one-third, or to 1·7 cents per person. Even at the 2·5 cent rate the cost, including time and attendance, compares favorably with other sources of heat for cooking.

IV. Industrial Applications.—In factory work all the elements for a multi-potential heat supply are usually present and the field for electrically heated devices extensive. Three examples have been selected as illustrating this class of work.

A. Equipment of a Brush Factory.—In this instance pitch is used to fasten bristles in the brushes and is kept above 300° F. in jacketed electrically heated pans. In addition, hot plates and glue pots are used, all heated by electricity. Current is derived from a dynamo driven by a gasoline engine. For a run of ten hours the cost of heating each pitch pan is about 4·5 cents, which is considerably less than was the cost of running by gas.

Commenting on his plant, the owner writes:

"When we built our factory we had confronting us the problem of obtaining high temperatures for heating pitch and other applications without employing gas or other forms of flames or fire in the shop which were objectionable from the underwriters' standpoint and which we have solved by the adoption of electricity for these purposes."

B. Sad Irons in a Linen Factory.—This installation consists of 125 9 pound irons heated to about 750° surface temperature. For this plant additional dynamos were bought, and its success is evidenced by the fact that it is shortly intended to double the equipment. Each iron uses 550 watts or about ¾ horse power per hour as a maximum.

C. Glue Pots in Book Binderies.—Two installations of 25 pots each. These show the value of electric heating in the subdivision of heat energy. The pots are provided with water bath, and the energy supply so adjusted as to compensate for heat loss without material evaporation. The energy used by each pot is from 150 to 200 watts.

These may be regarded as typical illustrations and indicate roughly the adaptability of electric heating in industrial work. Where electricity is used in place of flame or fire the ventilating problem becomes much simpler, and this is of great importance in crowded workrooms.

It is not too much to claim that electric heating will materially influence the work of heating and ventilating engineers. Now that electric lighting installations are handled by heating and ventilating engineers, it is a short step to render the entire heating system homogeneous, looking to one source—the boiler—for all the energy needed for heating, lighting and ventilating. It is possible to economically regulate and provide storage capacity for both the high and low temperature factors; the plant becomes compact, selfcontained and simple and economical in units of moderate size. The system is elastic to the highest degree.

EXPANSION BY HEAT.

ALL bodies expand when heated. It has been seen that a current passing through a wire heats that wire. Therefore, the wire will expand. We need only trouble here about the linear expansion—that is, the expansion in length or the elongation due to heat. It is found that if a bar of iron, for example, be raised in temperature, its elongation per degree of temperature is very nearly uniform at all ordinary temperatures. Thus, if we take a bar of iron at 0° C. a foot long and raise its temperature 1° C., and carefully measure the elongation (call it x), the length of the bar at the higher temperature will be 1 ft. + x the elongation. If we raise the bar two degrees, its length will be 1 ft. + 2 x; if we raise it three degrees, its length will be 1 ft. + 3 x, and so on, if the temperature is raised n degrees, the increase of length is n x.

The number representing the extension in length is called the coefficient of expansion. Thus, if the coefficient of expansion of iron is 0·000012, then a bar of iron

1 foot in length raised 1° C. becomes 1·000012 ft. in length;
1 yard in length raised 1° C. becomes 1·000012 yards in length;
1 mile in length raised 1° C. becomes 1·000012 miles in length.

If the bar of iron is raised 20° C. in temperature, then

1 foot in length raised 20° C. becomes

1 + 20 (0·000012) feet in length
= 1·000240 feet in length.

COEFFICIENTS OF EXPANSION FOR ONE DEGREE C. (KOHLRAUSCH).

Aluminum	0·000023	Brass	0·000019
Lead	0·000029	German silver	0·000018
Iron	0·000012	Platinum	0·000009
Glass	0·0000085	Platinum-iridium	0·000009
Gold	0·000015	Silver	0·000019
Copper	0·000017	Zinc	0·000029
Vulcanite	0·00008	Tin	0·000023

Note the similarity between the coefficients for glass, platinum and platinum-iridium. Advantage has been taken of this fact in the manufacture of incandescent lamps.—Electrical Engineer.

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